No. 14. — *Origin of the Land and Freshwater Mollusk Fauna of the Bahamas, with a List of the Species Occurring on Cat and Little San Salvador Islands* [1]

By William J. Clench

INTRODUCTION

The conclusions reached in this present study are based almost entirely upon the land and freshwater mollusks of the Bahama archipelago. Material from these islands at my disposal for study dates from Henry Bryant, Thomas Krebs, Sir Rawson W. Rawson, and others who had collected in the Bahamas about 75 years ago.

In addition to this early material, there have been studied the shells collected by several expeditions to these islands by members or associates of this museum, as well as specimens kindly contributed by L. Plate, H. A. Pilsbry and Don Waters. The following list includes only those expeditions in which we have been directly concerned.

Between 1883 and 1915, C. J. Maynard of West Newton, Mass., paid several visits to the Bahamas, mainly in quest of the genus *Cerion*. His entire collection was purchased jointly by the United States National Museum and the Museum of Comparative Zoölogy and equally divided between them. Maynard explored the islands of Andros, New Providence, the Berry Islands, cays between New Providence and Eleuthera, Rum, Long, Great Inagua, and the long series of islands composing the Exuma chain.

Alexander Agassiz, during the "Wild Duck" expedition in 1893, obtained a few land mollusks in the Bahamas. These were reported upon by W. H. Dall (1894, pp. 113–124). Dall also included in this report the records of shells collected by the "Albatross" and those collected by J. J. Brown on Watling Island. Collections by Mr. Agassiz came from New Providence, Eleuthera, and Watling Islands, Gun Cay, Bimini group, Great Ragged and Flamingo Cays in the Ragged Island group.

In 1904, Glover Allen, Thomas Barbour, and Owen Bryant visited the islands on the Little Bahama Bank and obtained a large collection of shells, which were subsequently reported upon by William H. Dall (1905). A portion of this collection was retained for the National Museum, the remainder returned to this institution. They visited New Providence, Grand Bahama, Little and Great Abaco islands.

[1] Lists of the Echinoderms, Reptiles and Amphibians collected are given at the end of this report.

During January and March, 1932, Mr. A. V. Armour's yacht, the "Utowana," visited these islands, which were included in a more extended trip to other parts of the West Indies and the coast of South America. Dr. David Fairchild collected a series of mollusks on New Providence, Cat, Conception, Rum, Mariguana and Great Inagua islands.

In January and February, 1933, the "Utowana" stopped at New Providence, Watlings, Crooked, Fortune, Mariguana, the Plana cays, Great and Little Inagua islands. Thomas Barbour, David Fairchild, and J. C. Greenway, Jr., collected a fine series of shells from all of these stations.

Again in February and March, 1934, the "Utowana" visited New Providence, Grand Bahama, Great Abaco, Eleuthera, Cat, Conception, Watling, Rum, Long, Mariguana, Crooked, Atwoods (Samana), Mira Por Vos and Great Inagua islands. As in the past trip, Thomas Barbour and J. C. Greenway, Jr. were responsible for the scientific collections obtained. On these expeditions the mollusks collected were purely incidental to other interests, but both Dr. Barbour and Mr. Greenway sacrificed much of their limited time to benefit their colleagues by collecting material for departments other than their own.

During July and August, 1935, the writer, accompanied by H. D. Russell and J. H. Huntington, visited New Providence, Cat and Little San Salvador islands. The collections made on the latter two islands are reported upon in this paper.

Early in April, 1936, I joined J. C. Greenway, Jr. and his brother, Gilbert, at Nassau, and in the latter's seaplane visited Grand Bahama, Mores, Little and Great Abaco islands. Late in April and through most of May, I collected the central and south central part of Eleuthera and on the south coast of New Providence. Prior to my joining the expedition, J. C. Greenway, Jr. and his brother had visited many of the southeastern islands during February and March by plane. The complete list of stations and the collectors are as follows:

Great Inagua, Little Inagua, Caicos and Turks Islands (J. C. and Gilbert Greenway). Southern Andros Island (J. C. Greenway, Jr.). Grand Bahama, Mores, Little and Great Abaco Islands (W. J. Clench, J. C. and Gilbert Greenway). Eleuthera Island (W. J. Clench). New Providence (W. J. Clench and J. C. Greenway, Jr.).

During July and August, 1936, H. D. Russell, accompanied by R. A. McLean, J. H. Huntington, and Richard Foster, visited New Providence and Long Islands. A very extensive collection was made on this latter island, the first expedition to do any systematic work.

Emanuel Williams, a native of Cat Island, was sent to Mariguana during December, 1936. His material from many new areas on this island supplements the "Utowana" collections.

Notes and descriptions of the new forms obtained by the several "Utowana" expeditions have appeared (Clench, 1933; 1934). A list of the land mollusks collected by Williams on Mariguana has also been published (Clench, 1937) as well as a short account of the trip in 1936 to the southeastern group of islands and those on the Little Bahama Bank (Greenway, 1938).

The above is given, not only to complete the records, but also to indicate the areas covered in part, at least, for mollusks. Little area now remains for any extensive work, two exceptions being Acklin Island on the Crooked Island Bank and the chain of islands composing the Ragged Island group. Certain of the few small islands on the Cay Sal Bank have recently been explored by Paul Bartsch of the National Museum, but the results of this expedition are as yet unpublished.

About 300 species and subspecies of land and freshwater shells are now known from these islands. This number does not include many of Maynard's forms of *Cerion* which will eventually be synonymised when studies are completed for the several remaining islands. The various expeditions mentioned above collected over 200,000 specimens which have been used in the present study.

For a great deal of general information on the Bahamas, reference should be made to "The Bahama Islands" (Geographical Soc. of Baltimore, edited by G. B. Shattuck, 1905, pp. 32+630, 93 plates, The MacMillan Co., New York). This publication not only embodies the results of an extended exploring and collecting trip to these islands in 1903, but also contains a summation, much of it in detail, of the published record concerning the zoology, botany, history, geology, etc., of this archipelago.

Origin of the Bahama Fauna

The several postulates and theories relative to the geologic history of the Bahamas need not concern us here if the thesis is accepted that these islands were completely submerged during the Pliocene and [early?] Pleistocene (Schuchert, 1935, map 16) and that the present fauna and flora has arrived by fortuitous means since that time.

Whether or not the present Bahamas had their origin in the Pliocene or Pleistocene is impossible to say. There is no evidence of the existence of fossil soils such as those found in the Bermudas. According to

Sayles (1931, pp. 449–456) the Bermudas have passed through several stages, climatic as well as change in area, during the Pleistocene. The evidence is based upon fossil soils interbedded between masses of eolianite. However, other than at the "Queen's Staircase" in Nassau, there are no deep road cuts through the lithified dunes in the Bahamas. Such cuts in the Bermudas have brought to light many of these fossil soils. At the "Queen's Staircase," Cerions are to be found in definite layers, many feet below the present dune surface. The matrix in which they are imbedded is a somewhat friable calcareous sand and the layers follow rather closely the present contour of the dune. As Cerions will exist on very scant vegetation, even that growing on loose sand, the layers mentioned above may have formed during an active rather than a specific period of rest in dune formation.[1]

We do not hold that the Bahama foreland was never connected with the islands on the south, but since its last disconnection, it has been submerged below sea level, and at no time since its elevation has this archipelago been connected to any other land area. In our opinion, the evidence based upon the occurrence and present distribution of certain land snail genera and species supports this view. Simpson (1894, p. 424) held this theory, based upon the evidence of the land mollusks. Our own conclusions are based upon far more material. Schuchert accepts this belief upon the work of Simpson and upon the botanical evidence brought together by Harshberger and others (*ibid.* p. 539).

T. Bland (1873, pp. 318–319) indicated the relationship of several Bahama species with those of Cuba and Haiti [Hispaniola]. His conclusion, drawn upon the limited number of species then known from these islands, was that the species occupying the Great Bahama Bank were closely allied with those of Cuba and the species of the easterly islands (Crooked Island group to the Caicos Islands) were affiliated with species of Haiti. He supposed upon this evidence that a connection had existed between the Great Bahama Bank and Cuba and one between the easterly islands and Haiti. The differences between these two island areas, though marked, is not nearly so exact as was thought by Bland. At that time almost nothing was known about the mollusk fauna of Long Island. This island, though on the Great Bahama Bank, possesses as many species and species groups in common with the islands to the southeast as it does with other islands on the same bank. His

[1] Such a condition is to be seen on the eastern side of Eleuthera, near Governor's Harbour. A small series of irregular dunes appeared active, to judge by the exposed root systems of the small scrub palms. Live Cerions were plentiful and dead shells existed in considerable numbers scattered over the sand.

data, however, are just as important for our theory, that the relationships in general of the Bahama mollusk fauna are due to island proximity and that they are in the paths of many hurricanes which cross the larger islands of Cuba and Hispaniola before reaching the Bahamas.

It is to be borne in mind that much of the Bahama archipelago is somewhat arid in nature. This is probably due to the general physiographic conditions of the islands rather than to climatic factors, as the poor water holding capacity of the soil, the large exposures of aeolian rock and the present day practice of burning, produce conditions similar to those found in regions of far less rainfall.[1] For this reason, many species could not maintain themselves in the Bahamas, no matter what method was open for their arrival.

During the Pleistocene, when the eustatic level of the ocean was much lower owing to the impounded waters as ice on the polar caps, the Bahamas emerged, forming much larger islands than now exist.

Daly holds, in his glacial control theory (1935, p. 47), that the greatest eustatic change lowered the present level about 75 meters or approximately 250 feet. A reduction of oceanic waters of this depth would have removed the ocean from most of the present Great and Little Bahama Banks. As a consequence, all of the islands on each bank would then have formed large single islands, the limits of these Pleistocene islands being close to the present 60-foot contour of the banks as they are today. Approximately at this contour the slopes change to a precipitous gradient leading to the profound depths of the surrounding seas. A positive eustatic change from this low ocean level would gradually fragment these larger islands into smaller land units and eventually reach the conditions as they now are. Of course, subsequent erosion and corrosion has further decreased the size of these islands, particularly on the inner or lee sides.[2] It was presumably at this low eustatic level that the dunes were produced that now form the present hills of the larger, easterly islands. Certainly no sand exists today on Cat Island in such sufficient quantities that could form the present hills that characterize this island. The Exuma chain of islands is apparently a fragment of what had once been the dunes fronting the Great Bahama Bank (island) along Exuma Sound. It is of interest to

[1] There is considerable yearly variation in the rainfall though the average appears to be about 50 inches (Nassau). Of this amount, four-fifths occurs between May and October (Shattuck, 1905, p. 117). However, in certain areas, notably Gt. Inagua and the Turks Islands, the rainfall is very slight so little over most of these latter islands that salt manufacture is possible by the evaporation process.

[2] At Governor's Harbour, Eleuthera Island, a mass of rock consisting of several hundred tons was broken off the sea cliff during the 1926 hurricane; other masses were seen of similar and lesser size, broken away during recent storms.

note that the islands possessing the highest hills (Eleuthera, Cat and Long Islands) have the most extensive shallow seas on the leeward sides, the only exceptions being Andros and Grand Bahama Islands which are comparatively low. The explanation for the low altitude of these latter islands is that during the period when the large areas of the present banks were exposed land, Andros being behind or in the lee of the eastern part of the Great Bahama Bank Island, lost the necessary wind velocity to form high dunes. Grand Bahama Island (elevation under 25 feet) on the Little Bahama Bank runs in an easterly-westerly direction and is in the lee of Great Abaco, which possesses hills upward of 100 feet. As the largest dunes form on the windward sides of land areas, the lithified dunes on the outer and windward islands can be explained in this manner, but they were formed only during the time when these islands were very much larger. Small lithified dunes that had their present base under the ocean level as it now exists, were noted at West End, Grand Bahama Island, indicating their origin at a time when the ocean level was lower.

As the ocean level rose, the extensive sand flats were gradually covered and the source of the raw material for dune formation was eventually cut off entirely, the process now being one of erosion and corrosion or only a very slight building on the easterly shores. As mentioned elsewhere there is evidence of some new rock being formed, but at most it seems to be limited and local.

A few of the present species of land mollusks probably arrived in the Bahamas at the time the larger islands existed and normal dispersal took place before the islands became fragmented. Specimens of *Hemitrochus varians* were found four feet below the surface of the aeolian rock on Eleuthera in a road cut at an elevation of more than 100 feet, and Cerions are to be seen in abundance more than 25 feet below the surface of a hill in the cut at the "Queen's Staircase" in Nassau. Both of these cases would indicate that these genera at least had reached the Bahamas during the dynamic period of dune formation.

All of the fossil land shells so far recorded from the Bahamas are very similar to recent forms, and it is questioned whether several of these are really different from present day species. At best, they would date only from the period of dune formation, those occurring in the coastal limestone may be of recent origin.

My belief in the drift origin of the mollusk fauna is based on the following points:

1. Occurrence in the Bahamas of several genera that also occur on

the lower keys of Florida and the Bermudas, of undoubted West Indian origin.

2. Possible rafting from Cuba and Central America by the Gulf Stream.

3. Hurricanes and the regular and irregular distribution of certain species and genera.

4. No endemic genera.

5. Wide distribution of many species.

1. *Genera common to the keys of Lower Florida and the Bahamas.*

There is a marked ecological similarity between many of the Florida keys and the Bahama Islands. This is an important factor in the argument, as genera that have managed to reach one region by fortuitous means could also reach the other, if the same way were open to their dispersal, and conditions in both areas were favorable for their maintenance upon arrival.

There appears to be no geological evidence of any land connection between Cuba and Florida, certainly since the lower portion of the Florida peninsula rose above sea level, yet several molluscan genera of undoubted West Indian origin are now known to occur on nearly all of the lower Florida keys. Such Cuban genera as *Urocoptis, Chondropoma, Lucidella, Macrocramus, Liguus,* and a few others are to be found on many of these keys between Miami and Key West. *Oxystyla* of the Florida Keys, is of Central American origin and *Drymaeus multilineatus* is a species known to occur in Yucatan and in Central America. All of these forms could have reached Florida by means other than any land connection.

Hemitrochus definitely and *Cerion* possibly of the Florida Keys are of Bahama origin. *Hemitrochus varians* Mke., the only species of this genus in Florida, occurs throughout most of the Bahamas. According to Pilsbry (1902, p. 215) *Cerion incanum* Binn. of the Florida Keys occurs also on Gun Key of the Bimini group of islands in the Bahamas. However, this latter species could have reached the Bahamas from Florida just as well. A closely related form, *C. sagraianum* (Pfr.), is found on certain islands off the northern Matanzas coast of Cuba; consequently derivatives of this form may have reached both Florida and the Bahamas independently from this area. It is to be remembered that the Bimini islands are probably only a fragment of a larger island or island group that fronted the western edge of the Great Bahama Bank and Gun Key is the remaining locality for a species that probably occupied a much wider area. A few species of *Cerion* in the Bahamas are exceedingly close in their relationships to *C. incanum.*

A Helicinid, *Lucidella tantilla* Pils., possibly reached Florida from Cuba, and then was carried to the Bahamas, as it only occurs in this latter region in the northwestern portion of the archipelago. In Florida it occurs on the southern keys and up the East coast as far as Palm Beach.

It seems to us that if such genera have managed to survive mechanical transport into one region, the same agencies could be responsible for their transport into others, particularly when the distance between the northern Antilles and the Bahamas is no greater.

It is quite possible of course that other Bahama species *may* have reached Florida, but have been unable to survive continental competition. It is of considerable interest to note that neither *Cerion incanum* nor *Hemitrochus varians* has been collected on the mainland of the Florida peninsula but only on the lower keys from Miami south. There is no definite answer to this distributional problem, but it is possible that the lack of certain enemies, maybe mammalian, that do not range over these small islands, make it possible for these mollusks to exist. The distribution of these mollusks over most of the lower keys is too extensive not to have included portions of the mainland unless some sort of eliminating factor is responsible for their non-occurrence.

The above case may possibly be a parallel to the situation existing in the bird fauna of Cozumel Island off the coast of Yucatan. According to Griscom (1926, p. 8) there are several species of West Indian Birds on this small island not known to occur on the adjacent mainland of Mexico. This has given rise to the belief that Cozumel Island was connected with Cuba during rather recent times. However, a survey of this island by Richards (1937, pp. 249–262) for land and freshwater mollusks shows unmistakable evidence of purely Central American affinities. Twenty-two species of mollusks were obtained and, of these, four were new though closely related to forms occurring on the mainland, fifteen were identical to mainland forms and three were wide ranging species known from many localities on the Continent and West Indies. It would appear then, that the birds may represent migrational or accidental stock that have been able to survive on this coastal island but not on the highly competitive area of the mainland.

2. *Rafting.* The Gulf Stream is a possible factor in aiding certain forms to reach these islands. The genus *Schasocheila* (Helicinidae) is only known to occur in Central America and in the northwest Bahamas. In this latter region it is only found on the islands of the Little Bahama Banks, Andros, New Providence and Eleuthera. The western sides of both these banks are washed by the margin of this current. It is a

ground form, generally found about the roots of grass and other vegetation and as such would be subject to transport by floating debris, washed out by rivers during heavy rains. (*Oxystyla* and *Drymaeus multilineatus* in Lower Florida are forms that may have reached Florida in this way). Inter-island dispersal may have since been by hurricanes, or normal distribution took place before these islands became fragmented. Other species occurring in the Bahamas may have arrived in this same manner, but as they are of undoubted Cuban and Hispaniolan origin the method of transport cannot be differentiated from other means.

Both sides of the possibility of animal distribution by rafting have been considered in detail by Matthew (1915, p. 206–209) Barbour (1916, p. 1) and Hesse, Allee and Schmidt (1937, p. 56–71).

3. *Hurricanes.* Dispersal by means of these cyclonic storms in the Bahamas is probably our strongest argument. The very mixture of many species and even the regularity of others appears to offer no other solution.

An analysis of the hurricane charts published in Shattuck's report covers a period of 25 years from 1878 to 1903. A little over 100 hurricanes have occurred during this time, and of that number, 28 have passed over the Bahamas.[1] Of the 28 hurricanes, 8 have passed over Cuba, 9 have passed over Hispaniola and 1 over Florida before reaching the Bahamas. The remaining 10 had their origin in the Bahamas or on the Atlantic Ocean to the east and southeast. This is an approximate average of one storm a year.

Actual observation of transport by these storms is of course lacking, but there is an abundance of evidence of their destruction and carrying power during the several hurricanes that have passed over Florida, Cuba, Hispaniola and elsewhere in this region during the past few years. Certainly, small objects such as snails, insects, spiders and even birds and bats could be transported by these storms. Land mollusks particularly would be subject to such means of dispersal, as many species of *Cerion, Hemitrochus, Plagioptycha* and others find concealment under and in the curled and twisted dead palm fronds and on many other types of debris subject to wind movement. Such means would explain the erratic and anomalous distribution of species, particularly among the *Urocoptidae, Helicinidae* and certain races of *Cerion.*

McAtee (1917, p. 217) reports from many sources a surprising num-

[1] A 50 mile radius from the storm center or "eye" has been used for the above number. Many more storms could be added that have caused hurricane conditions in these islands.

ber of instances of organic matter being "showered" down. These records include numerous references of invertebrate and vertebrate animals that have been wind borne and deposited over areas considerably removed from their original source. These appear to be mainly the results of cyclones.

Small cyclonic storms, though not abundant, do occur in the Bahamas. Though they are usually limited to narrow paths, the dispersal factor may be quite important, as the ascending currents may well carry small objects to a considerable altitude, to be scattered later over a much wider territory when the wind velocity has lessened.

Many species and varieties of land mollusks are more or less regularly disposed over the southeastern groups of islands, namely: Mariguana, Inaguas, Crooked, Turks and Caicos groups. These islands are all surrounded by very deep water, and their present fauna certainly post dates the period when these islands were connected, if such a connection ever did exist. A few of these species and species groups even extend northwest to Long Island, which is the first and nearest to these southeastern islands of the several islands on the Great Bahama Bank. These species have not as yet managed to spread beyond this point. If any sort of land connection existed between all of these islands, the distribution should be far more even. Land shell distribution throughout this archipelago indicates a relationship only on the basis of island proximity and not on a possible geologic history of island associations and connections as one would expect.

Another case in question is that of *Lucidella tantilla* Pils. which has been found only on the islands of the Little Bahama Bank and the Bimini group. The identical species occurs only along the coast of Florida from the lower keys north to a point opposite these islands. Strikingly enough, these islands of the Bahamas are in the direct path of many of the hurricanes that first pass over Florida, their trend from southern Florida is generally in a northeasterly direction. Careful search for this *Lucidella* has failed to locate it on any other of the Bahama Islands. The species is less than 3mm. in size and is found on the forest floor on and under dead leaves.

Differences and similarities generally in the snail fauna of the several islands on the Great Bahama Bank are no greater on the whole than the differences between the fauna of these islands and the several isolated islands to the southeast.

It is usually held that the degree of difference between the faunas of separate land elements is more or less correlated with the length of time of such a separation. Upon this assumption, one would expect

the faunas of the Crooked Island Group, Watling, Rum, the Inaguas, etc., to show greater differences between themselves and between the islands of the Great Bahama Bank than the existing differences in the fauna between Cat, Long, and Eleuthera Islands, which are all closely associated on the Great Bahama Bank. The first group of islands are all separated by depths exceeding 850 fathoms, the latter group of islands are separated by depths that nowhere exceed 20 fathoms, yet the snail fauna of Long Island is closer in most of its relationships with the fauna of the islands in the Crooked Island group than its fauna is with New Providence, an island on the same bank. In the former case, depths of 1182 fathoms exist between Long Island and the Crooked Island group, and depths of less than 5 fathoms exist between Long Island and New Providence. It would appear to be a difference of distance and the factors of chance in the mechanical distribution or dispersal of the fauna. In the first case, Long Island is separated from the Crooked Island group by 30 miles of open sea and separated from New Providence by a distance of 160 miles.

4. *No Endemic Genera in the Bahamas.* It would appear that if the fauna of the Bahamas had arrived before the Pleistocene, at least a limited number of endemic genera would occur, similar to the case of *Poecilozonites* in the Bermudas. All genera and but one subgenus now known to occur in the Bahamas, occur elsewhere in Cuba, Hispaniola, Florida, etc., and even many species are identical to those of these places. Endemic species are also closely related to those in Cuba and Hispaniola, particularly to forms occurring on the north coast of Cuba.

5. *Wide distribution of many species.* Many of the common species exhibit a very wide distribution among the islands of the Great and Little Bahama Banks and even extend to the isolated islands of the southeast. Certain of these, such as *Cerion agassizi* found fossil in the cut at the Queen's Staircase in Nassau and *Hemitrochus varians* found fossil in a road cut on top of the high hill back of Governor's Harbour on Eleuthera Island certainly date their origin to the dynamic period of dune formation. Others, however, may have been dispersed mechanically since the Bahamas became fragmented.

It is of value, however, to note that *Hemitrochus varians*, the most abundant species numerically at any one place and one with the widest variety of habitats is the species most generally distributed in the islands. From a numerical point alone, it stands the greatest chance of being carried from one place to another and its arboreal habit adds materially to its distributional opportunities.

A recent paper by A. Gulick, (1932, p. 405–427) gives considerable

data on the number and types of animals and plants that are known to occur on a few oceanic islands. The islands under consideration are those that are universally accepted as "unmistakable oceanic islands . . . . whose terrestrial fauna acknowledgedly cannot have arrived by the land-bridge method."

All of the islands enumerated by Gulick exist at far greater distances from other islands and continental land areas than do the islands that compose the Bahama archipelago. As far as known, none occur in regions receiving the number of hurricanes that frequent the West Indies. If such islands have been successfully populated even in a very limited way by mechanical means, a postulate of the same sort for the origin of the Bahama fauna and flora does not appear impossible but highly probable.

The origin of the vertebrate fauna is much harder to account for—particularly by any hurricane method, but the possibility of rafting certainly falls within the realm of chance dispersal. According to Gulick, Marcus Island in the mid-Pacific area possesses two Polynesian species of reptiles, a gecko and a skink (p. 407) yet the nearest land, the Ladrone Islands, is 600 miles to the southwest. An endemic species of skink occurs on the Bermudas. These islands are distant some 575 miles east of continental North America and 840 miles northeast of the Bahamas. In both of the above cases, reptiles have managed to survive transport over a very great distance of open water. Other examples could be quoted from Gulick, but the above indicate the possibility of colonization by some means of mechanical transport.

In connection with Bermuda, certain species of snails, *Physa cubensis* Pfr. and *Polygyra plana* Dkr. are identical with those of the Bahamas and *Helicina convexa* Pfr. of Bermuda differs only slightly from a variety, *H. convexa rawsoni* Pfr. of the Bahamas. It would appear that the three species have reached the Bermudas directly from the Bahama Islands, only the *Helicina* has become somewhat differentiated. These are only two of the several that have reached the Bermudas from other areas.

The raccoon, which occurs only on the island of New Providence in the Bahamas, has been considered as a race or subspecies of the widespread North American raccoon. In a recent conversation I have had with my colleague, Dr. Glover Allen, he stated that this particular "race" of raccoons could possibly date from a recent introduction, probably during early colonial times. Catesby (1731, p. xxix) makes no mention of the raccoon as occurring in the Bahamas, though he gives a general account of its range and habits in North America. Such an

animal would certainly have been brought to his attention had it occurred on New Providence at the time of his visit in 1725. For the Bahamas, except the Jutia, which he calls the "Coney," he has listed only domesticated animals and a rat, this latter probably the introduced brown roof rat.

James Bond, in a general account on the distribution and origin of the West Indian avifauna (1934, p. 348) considers the Bahamas as oceanic islands. He does not, however, give any reasons for this statement but claims otherwise that "the resident Bahaman bird fauna has been chiefly derived from Cuba and Florida, the more distinct and older forms being predominantly Cuban, the Florida element being mostly confined to the northeastern islands."

The occurrence of the fresh-water turtle, *Pseudemys felis* Barbour, at Tea Bay, Cat Island, may possibly be an introduction by man. It does not appear necessary to consider this species as a remnant of a fauna dating from a previous land connection with Cuba or elsewhere, nor do we have to suppose that the entire fauna of these islands is of hurricane origin. Recently my friend, Dr. T. Barbour, has published a note on this species of turtle (1937, p. 164) and stated that he believed it would be utterly impossible for this animal to reach Cat Island by the caprice of any hurricane. With this I fully agree, but no consideration is given to the possible introduction by man. The ecological situation which *Pseudemys* occupies on Cat Island is fairly large; that is, the rocky-bottom pond area behind the lithified dunes near the western coast of the island, yet the turtle is limited to a very small part in this habitat at Tea Bay. It would seem to us that such a restriction of territory occupied would have some explanation, and that a comparatively late introduction of this species would be a possible answer. As far as we could learn, this turtle is not eaten by the natives, so its absence from potential areas is apparently not due to this cause. We were very politely informed that the Bahamians do not eat "insects"! That it differs somewhat from its nearest Cuban relative does not appear to be an insurmountable difficulty in explaining its origin. The speed of differentiation of animals under conditions of isolation is not known, but that such a condition can occur in a comparatively limited time is exemplified by the various breeds of domesticated cattle found on certain of the islands and island groups off the coast of Europe. Unit populations, possibly and probably derived from a very few or even single individuals would naturally show a surprising uniformity among themselves. Cases of this sort are exceedingly abundant among mollusks.

Again, we do not possess a complete series of *Pseudemys* for comparative study from all of the river systems of the Greater Antilles. This form may still remain undetected somewhere within the range of the genus.

Primitive man may have been responsible for some introductions. The use of these turtles for food may have prompted some Indians or even early Spanish sailors to provision their boats for a voyage from the Greater Antilles to the Bahamas. Again, some early colonial may have purposely brought them for use as food or for pets. At the present time Commissioner Malone of Simms, Long Island, possesses several Gopher Turtles (*Xerobates*) that he imported from Florida. If these turtles escape or are released they may well become a definite part of the reptilian fauna of Long Island. Conditions are ideal for these animals on most of the Bahamas. Such an introduction, unrecorded, would naturally lead to considerable speculation a few years hence if they were to be rediscovered in a wild state.

The distribution of *Geocapromys*, the Jutia, may have been extended by the Lucayan Indians to the more remote islands. They are easily tamed as pets and their usefulness as food, particularly during any sea voyage, may have prompted an occasional use of these animals.

During April, 1936 while exploring the islands of the Little Bahama Bank (Grand Bahama, Little, and Great Abaco Islands) by means of a seaplane, Mr. James Greenway and I noted a remarkable line of drift material along the northern portion of Great Abaco Island. This drift of trees and brush was well over two miles inland in many places from the western shore line of this island and upon ground investigation it was estimated conservatively to be 15 feet above the present or normal high tide level. In places this mass of debris was 5 to 8 feet deep and 20 feet wide. This was caused by the very severe hurricane of the previous year. A portion of this debris was probably derived from Grand Bahama Island and other small islands to the west of Great Abaco, which lie at no great distance from this island. The possibility of rafting animals at this time must have been exceedingly great to judge entirely by the enormous amount of drift that was seen. It is important to realize the abnormal height of water brought about by such a storm. This would have a two-fold effect in driving out animals over portions of the flooded land in one area and with the debris, depositing them well inland in another. Even if we grant optimum topographical conditions in this particular region, for the height of water and the abundance of drift material, chances, very much less than these, over any period of time would still offer many similar opportuni-

ties. Such conditions would not appear to be entirely inimical to vertebrates as a mode of involuntary transportation.

There is no question but that the present day fauna and flora of these islands is somewhat poorer than that existing in pre-Columbian times. A recent sending of cave material from Great Exuma Island contained the bones of an extinct variety of Jutia (Allen, 1937, p. 369) only recently described from a similar deposit on Crooked Island (Lawrence, 1934, p. 189). In addition, the bones of two new species of hawks and a large owl was contained in these remains from Exuma, (Wetmore, 1937, p. 427). Catesby (1731, p. xxxviii) records the presence of the West Indian seal on the Bimini Islands. These latter of course have long since disappeared from the Bahamas and the former from the earth.

The vegetation could never have been luxuriant except in limited areas to judge by Catesby's statements relative to the rather thin soils and exposed rocky regions that he found during his early visit to the islands (*ibid.* pp. xxxix–xl)..... "Tho the Trees on these rocky islands grow generally not so large as in Virginia and Carolina, where the Soyl is deep, yet it is amasing to see Trees of a very large size grow out of Rocks, where no Soyl is visible, and the Rock solid and compact, before the roots found a way to separate them, particularly Mahogony Trees, which are usually the largest Trees, these islands afford, and are commonly three, and many of them four foot through."

The above record of Catesby would indicate that the conditions during the early post-Columbian period were somewhat different than now, and that much of the island areas other than mangrove swamps (Grand Bahama and Andros) and some pine land have suffered materially from human occupation. Naturally, any pronounced change in the ecology of these islands would bring about a modification in both the fauna and flora. These changes would be detrimental to many species, particularly animals, and species introduced by man would hardly offset the losses brought about by the altered conditions.

Summary

Our contention, based principally on the land shells, is that the fauna of the Bahama archipelago possibly dates only from the Pleistocene and that it has reached the Bahamas by fortuitous means.

If at any time a land connection existed between the Bahamas and the islands to the south, such a connection disappeared, the islands

were submerged, and since their emergence, there has been no further land connection.

Certain genera, such as *Cerion* and *Hemitrochus* reached the islands at least during the active period of dune formation, presumably at a time when the islands were much larger than now.

The present land and fresh-water mollusk fauna is disharmonic and as such, would indicate an origin by means other than any land connection.

The mollusk fauna of the Bahamas is composed of species from Cuba, Hispaniola, southern Florida and a genus, *Sehasocheila*, is known to occur only in Central America and Mexico. Most endemic species and species groups of the Bahamas are closely related to species in Cuba and Hispaniola.

The proximity of islands to one another rather than the probable geological connections between such islands, exhibits faunistic relationships, and these relationships would indicate mechanical rather than a previous and normal migrational distribution.

Cat Island

A period of five weeks, during July and August of 1935, was spent on Cat Island, Bahamas, and included a two-day trip to Little San Salvador Island off the northwest end of Cat Island.

Studies were made mainly of the land and fresh-water mollusks, especially the colonial development and distribution of the genus *Cerion*. However, collections of other groups were made, particularly of reptiles, amphibians, fresh-water fish, insects, spiders and echinoderms.

The party consisted of Henry D. Russell, John H. Huntington and the author.

Cat Island forms an eastern arm of the Great Bahama Bank, though its connection with the Bank is only by a very narrow submerged strip about 27 miles long between the north end of the island west to the southern end of Eleuthera. Little San Salvador Island and a few small keys associated with it are situated about two-thirds the distance between Cat Island and Eleuthera on this connecting strip. Cat Island itself is 42 miles long and possesses an average width of 4 miles with an approximate land area of 160 square miles. Its long axis trends N. W. to S. E.

Our own collecting was limited to the northern fourth of Cat Island and to Little San Salvador. Emanuel Williams, a native of the former

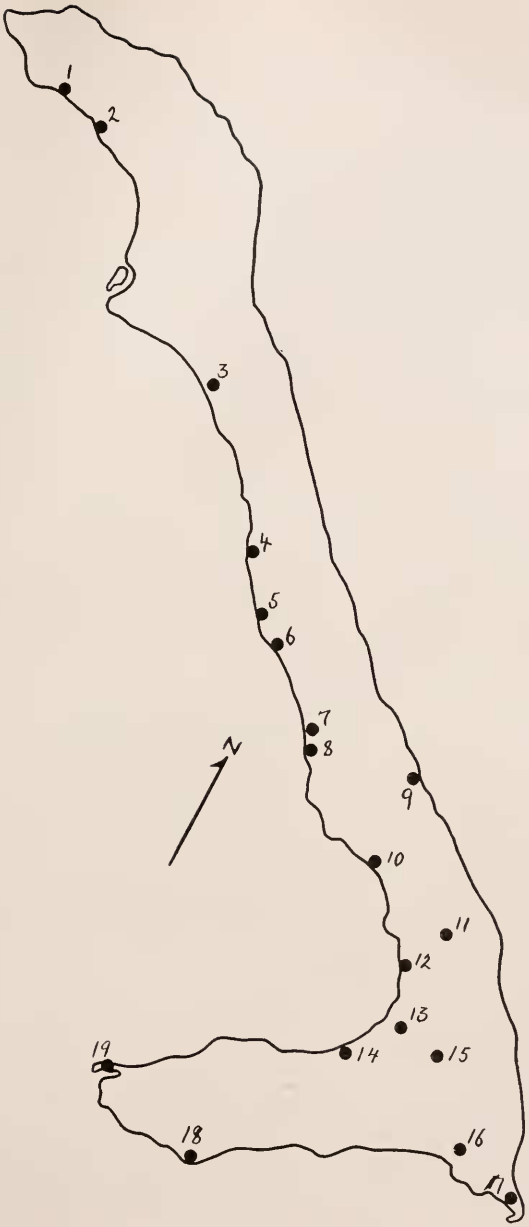

Fig. 1

Cat Island

(about 8 miles to one inch)

1. Orange Creek; 2. Arthurs Town; 3. Roker Settlement; 4. Cove Settlement; 5. Tea Bay; Drum Rainie, ½ mi. E. of Tea Bay; 6. Hollywood; 7. Knowles; 8. Smith Town; 9. Turtle Cove; 10. The Bight; 11. Tennent Hill; 12. Old Bight; 13. Gambier Lake; 14. Joe Sound Creek; 15. Bain Town; 16. Port Howe; 17. Columbus Point; 18. Devil Point; 19. Hawksnest Point.

island, made two trips of several days each for us to the southern part of Cat Island for *Cerion*.

Cat Island possesses the highest altitudes known in the Bahamas, the highest point being about 400 feet near the approximate center of the island and not far from the town known as The Bight. Many ridges run the length of the island and are generally about 150–200 feet high. However, they are not always parallel nor continuous for any distance, but are broken by gaps and occasional intersecting ridges. Their main direction is, however, with the long axis of the island.

In the vicinity of Arthurs Town, the region we personally explored, the island is about 4 miles wide, reaching a width of 5 miles about 3 miles south of the town. With the exception of Mr. Albury, the resident commissioner, the island population of about 4000 people is composed entirely of negroes. The natives live in small picturesque villages that are scattered along the western side or "inside" part of the island. Their small whitewashed stone houses are usually surrounded by clumps of palms and bananas.

The western side is the part of the island reached by the mail and supply boat from Nassau. Port Howe is on the extreme southern end of the island and the only place of any importance on the exposed outer coast. On all but the western side the water is of considerable depth just a very short distance off shore; 2194 fathoms are recorded 10 miles east of Columbus Point. The entire western side between Hawksnest Point (south end) and Man o' War Rocks (north end) shelves to the west rather gradually for some 10 miles to a depth of 40 to 50 fathoms and then suddenly drops into the deep water of Exuma Sound. The only continuous shallow area is the narrow strip mentioned above connecting the northern end of Cat Island with Eleuthera.

Arthurs Town is on the western side, 4 miles S. E. of the northern tip of the island. It has a population of about 300 people, and their dwellings are mainly within a few hundred feet of the shore. Immediately behind (east of) the town, the land rises to about 20–30 feet to form a flattened ridge. This ridge is about 1500 feet wide, and is covered with a low scrub, occasional areas being given over to farming.[1]

Beyond this first ridge there is a half mile of "swamp land," a sec-

[1] The farms, at least throughout the northern part of the island, are worked entirely by hand. Areas of sandy loam are very limited, though a long and very narrow strip occurs along the eastern side of the island. This is termed locally as the "white land." Nearly all other areas are rocky and the soil is to be found in the solution holes and between the large ledge limestone blocks.

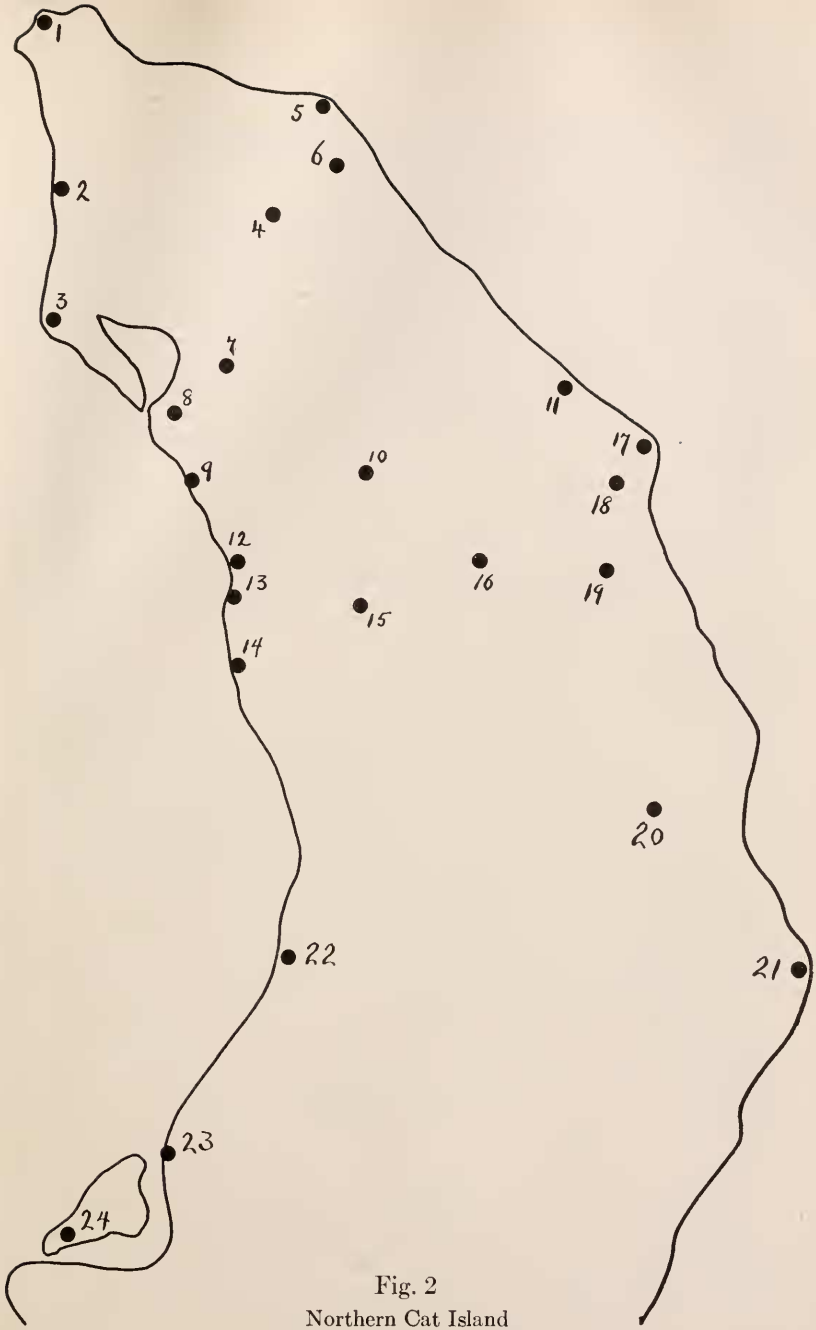

Fig. 2

Northern Cat Island
(about 2 miles to one inch)

1. North End Point; 2. False Creek; 3. Port Royal; 4. Blue Hole Hill; 5. Grape Point; 6. Bat Hole; 7. Russell Creek; 8. Orange Creek; 9. The Lot; 10. Mt. Pleasant; 11. Fountain Hill; 12. Arthurs Town; 13. Zion Hill; 14. Dumfries; 15. Laurimore; 16. Winding Bay; 17. Coarsand; 18. Barrataria; Stormy Battle; 19. Zingo Hill; Anguilla; 20. Smoky Point Lake; 21. North East Point; 22. Wilson Bay; 23. Bennetts Harbour; 24. Rock Cay.

tion which presents one of the most remarkable areas on Cat Island. It is not in any way a swamp as the term is understood in the United States but rather an area of very slightly rolling country, covered with a nondescript growth, including cocoplums and palms, with many small, shallow, fresh-water ponds. The entire area, as we found it, is mainly exposed aeolian limestone with very little soil cover in the areas between the ponds. During very wet weather many of these ponds are connected and probably they are dry after any considerable period of drought. About three miles N.N.E. of Arthurs Town we were shown two "fountains," very deep pools in solid limestone rock which probably correspond geologically to the cenotes of Yucatan. Fresh-water fish are found in considerable numbers in these "fountains," and they undoubtedly supply the fish in the temporary ponds in their vicinity during the flood stage. We did not find any fish in the temporary ponds that were distant from the "fountains" or cenotes mentioned above.

East of this region of ponds, the land rises abruptly to about 100 feet (3 miles east of Orange Creek this ridge is nearly 200 feet high) to form a plateau, with an average width of about 1½ miles. This plateau is covered, similar to the low ridge back of the town, with a scrub forest and is also farmed in a few places. East of this plateau the land drops to nearly sea level, is swampy in spots, and possesses many small brackish lakes or ponds. From this, the land again rises to form a fairly broad and somewhat rounded, sandy loam ridge. Here is found the best farm land which is cultivated extensively for corn, tomatoes, a little sisal and coconuts.

The outer sandy beach is fairly steep, having in some places flat limestone ledges and in others the usual small, rocky points of dog-tooth limestone separating short or long stretches of sandy beaches. The flat ledges are closely allied to the "coquina" rock of the Florida east coast, though the component grains comprising this rock are much smaller than the Florida rock found near St. Augustine. A reef extends about 17 miles along the northern and northeastern portion of the island.

Some 4½ miles N.N.E. of Arthurs Town there is a sizable salt-water lake known as the "Blue Hole." This is about two miles from the ocean from either side and except for a low area on its northern end is, as far as surface areas are concerned, completely isolated from the ocean. The low mangrove area on the northern end connects with another lake about one half mile away. The "Blue Hole" is very deep and possesses all of the features common to a small arm of the sea, with

tides, a marine fauna and, in addition, is margined with very heavy growth of mangrove. It unquestionably possesses a large subterranean connection with the ocean. A great many superstitions are associated with this place and no native will ever venture in it or even on its surface. Undefinable "creatures" are recorded locally and even mermaids have been reported!! It is possible that sharks or barracudas, both of which are common on all sides of the island, may occasionally frequent this place and that the sight of these has given rise to the stories.

One and one-half miles northwest of Arthurs Town is located the little village of Orange Creek. This village is on a "creek" of the same name. In reality this "creek" is a shallow tidal lake about a half mile wide at its widest point and one and one-half miles long. It is connected with the ocean by a shallow opening about 100 feet wide. At low tide this lake is nearly dry and possesses extensive sand and mud flats.

We saw no true streams on the island as the drainage is almost entirely subterranean; but midway in the "swamp land" we crossed a creek bed which was dry at the time we were on the island. This flows during a period of heavy rain.

Names for areas on the island exist in great abundance. Boundaries are defined mainly by the many trails that cross the island in all directions. We have indicated on the map all such names that are in any way associated with the material collected. The origin of most of these names lies buried in the Island's past history, though the origin of many could probably be determined by a perusal of the original land grants that were made in the eighteenth century. These grants were made mainly to loyalists from the American Colonies during and after the Revolution, these being the first whites in any number to settle the Island.

The unfortunate practise of burning the vegetation to clear the land is causing the soil to disappear fast. If this continues, in a few more generations, there will be little or no agriculture possible.

A small area is partially cleared, usually the largest trees are cut down and then allowed to dry. A day is selected for burning after a period of several hot sunny days. Late in the morning the brush is fired and in a short time nothing is left but a few charred stumps. Much of the top soil burns as it is composed almost entirely of humus. Most of the areas we noticed being cleared in this manner possessed a 10 to 15 year stand of scrub growth. Such cleared ground appears to be fairly productive the first year only, though it is usually farmed for

two to five years after each burning. The little soil remaining after such fires is soon impoverished both by the crops planted and through leaching. A new farm area is then selected and the firing process repeated. The abandoned farm ground gradually comes back into scrub and eventually is burned over again.

All stages of this clearing process were encountered in different parts of the Island, and other than the "white land," which is composed mainly of sand, the only real soil cover was found in the cemetery at Arthurs Town. Several feet of soil covers the rock at this place and its existence is due to the fact that the grass and brush is cleared off by cutting.

In the past history of the island, one reads of the noble estates that existed and the comparatively large fortunes made by their owners. These estates existed prior to 1840 during the days of slavery and after abolition the enormous estates practically disappeared and now only exist as a background in the Island's history. One is certainly suspicious that these estates failed more through the loss of the soil than the loss of the labor to work them. It is a paradox certainly when a country is predominately agricultural and yet cannot use a plow! Today, the entire mechanics of crop culture is limited to a grub hoe. Conditions are not so serious all over the Bahamas, as many parts of Eleuthera and New Providence are still very productive, but the same general destructive measures appear to be employed everywhere, and it is only a matter of time when these areas will be as non-productive as the sections seen on Cat Island.

One of the most astonishing discoveries was the enormous number of "Red Peggies," the Black Widow Spider, *Latrodectus mactans* (Fabr.). These were found under nearly every loose rock and under many dead palm fronds. During the time of our stay a girl was bitten, though the bite did not prove to be fatal. Several cases of bites that had occurred previously were brought to our attention, only one of which had been fatal. The victim was said to have lived only 10 hours after he was bitten.

Large ground spiders (Therophosidae) are to be found, though not particularly abundant.

Surprisingly enough, mosquitoes were not at all troublesome, notwithstanding the fact that we were located on the edge of a rather extensive brackish pond and not a great distance from the numerous fresh-water ponds of the "swamp land." A strong sea breeze may have helped to keep them away, but on our numerous daily trips we never noticed them at all even when the sea breeze could not be felt.

Marine collecting was necessarily limited as our main interest was connected with the land and fresh-water fauna. A list of the lamellibranchs has been published (Clench and McLean, 1936). The gasteropods obtained will be included in a list of all the known species found in the Bahamas. The appended list of echinoderms was furnished by Dr. H. L. Clark, based upon the material collected. All specimens of echinoderms were collected in a very small cove at the south end of Arthurs Town and all but *Oreaster reticulatus* were found under loose rock, the latter species occurring on exposed sandy bottom in 2–3 feet of water.

Little San Salvador

The island of Little San Salvador, as mentioned above, lies about two thirds of the distance between Cat Island and Eleuthera and is situated on the narrow submerged ridge connecting these two islands. The water covering this submerged ridge between Cat Island and Little San Salvador is exceedingly shallow (1 to 3 fathoms), with a few small rocks and keys near the Little San Salvador end. Numerous coral patches cover this ridge and many of them are awash at low water. The continuation of this ridge between Little San Salvador and southern Eleuthera is very much deeper (8 to 10 fathoms).

Little San Salvador, called locally on Cat Island "Little Cat Island" or just "Little Island" is 5½ miles long and approximately ¾ miles wide. A large "creek" occupies much of the central area and is connected with the ocean by a narrow opening on the south side of the Island. This "creek" which is similar to the one at Orange Creek on Cat Island possesses extensive sand flats at low water. It deepens considerably in the central and western end. This latter portion can easily be reached by walking a few hundred feet overland from Salt Pond Bay on the southwestern side of the Island. It is very rich in marine life and we found some of the finest collecting in and about the mouth of this area.

The Island is uninhabited, though farmed in very limited areas by people from Cat Island. The statement by Agassiz (1894, p. 34) that it is "low, not more than twenty feet high" is erroneous. He did not, however, visit the island, but judged its height during his cruise along its shores. Ridges on the north side of the "creek" are 100 feet high and many other sections of the island exceed 50 feet in altitude. Structurally, it is similar to Cat Island with large exposures of aeolian rock and sections of "white land." It possesses in places a much better

soil cover, simply because it has been much less cultivated, and fewer fires used to clear the land. Excellent anchorage is to be found, even for very large boats just off Salt Pond Bay on the south side. The deep water of Exuma Sound reaches within 1000 feet of this cove, and for small boats ample protection is to be had from all quarters other than the southwest, a region from which the wind seldom blows in this particular area. Near the small automatic light on the south side is found an excellent example of a lithified dune running north and south, completely and vertically truncated by wave erosion. This forms a sea bluff 15 to 20 feet high and its arched, laminated structure can be studied in detail.

Both *Cerions* and *Cepolis* were rare, though it is more than possible that colonies of both are to be found in numbers in sections we did not explore. Our time on the island was limited to a day and a half, and only a very small area was covered in this time. No *Cerions* or *Cepolis* were found on Goat Key, a small island of only a few acres in extent and about 50 feet high, lying about one mile off the northeastern end of Little San Salvador. Bird Rock and Sandy Key were not visited. Our collector, Williams, who had spent considerable time on both of these little islands could not recall having seen any land shells.

Our personal thanks are due to several friends of the Museum who, through financial aid, made this trip possible, and in addition to C. M. B. Cadwalader, Director of the Academy of Natural Sciences, Philadelphia, and F. M. Gaige, Director of the Museum of Zoology, University of Michigan, who supported the expedition in part for a share of the material collected. Duplicate collections of the mollusks obtained are deposited in these institutions.

We are also deeply obligated to members of the Development Board of Nassau, especially to Miss Sylvia Johnson and Mrs. H. Kelly for their assistance in supplying information and their willingness to cooperate in every possible way to make our expedition a success.

To the Bahama Government we wish to express our thanks for the use of a splendid dwelling house at Arthurs Town and to Mr. H. Christie for his very friendly interest and permission to photograph his colony of flamingos on his estate near Nassau. To Mr. Albury, Commissioner of Cat Island at the time of our visit, we are very grateful for his assistance in many ways and for his continued interest in our expedition throughout our stay on the Island. To the people of Arthurs Town and Orange Creek we wish to acknowledge our gratitude for a host of favors and for their friendly interest. Particularly among these people we owe our indebtedness to David and Reginald Poitier

and to Campbell, Clark, Bowleg and MacDonald for their many favors and courtesies.

Last, but not least, we are grateful to our "boys," Al Newbold, Ben Hepburn and Manny Williams for their willingness and hearty cooperation.

Ecological Areas

Aquatic habitats. In the introductory note there was mentioned the existence of several types of ponds on Cat Island. These ponds can be readily divided into four very distinct types, none of which are joined with the sea by any surface connection. In this classification, the "creeks" are not considered, inasmuch as they are really arms of the sea, reaching inland some distance by means of shallow and rather narrow entrances. These four types of ponds can be considered as follows:

1. Salt or brackish water
    a. Shallow salt marsh ponds.
    b. Deep "Blue Hole" ponds
2. Fresh water
    a. Temporary shallow ponds
    b. Permanent deep ponds.

Salt marsh ponds. A typical pond of this sort parallel to the coast, ran well beyond the limits of Arthurs Town in both directions, a distance of about two miles, and seldom reached a width of more than three-hundred feet. It was crossed at regular distances every few hundred feet in the town proper by fills built to form narrow roads. In many places, it was less than one-hundred feet from the sea, and separated from the sea by a rocky ridge six to ten feet high throughout its length. A small, two foot drain had been cut through the ridge near the main part of the village to keep the pond level fairly low.

Severe storms, particularly hurricanes, carry quantities of salt water over the rocky rampart and consequently keep the water brackish. There may, of course, be subterranean connections, but these, if they exist, could not be detected. Mangroves are found about the edges in many places and probably were all about the pond originally.

Ponds of this sort are particularly abundant along the east or outside margin of the island, usually only a short distance from the sea. They vary materially in size from those of an acre or so in area to one approximately a mile in diameter. It would appear that these ponds, particularly the larger ones, form a stage in the geologic history of the

"creeks." A narrow opening cut through the beach rampart, allowing the sea access to the low area behind would shortly develop such a place. Their surface is only slightly above or equal to that of the ocean at high tide.

Deep "Blue Hole" ponds (salt). We visited only one pond of this sort, though we were told that others existed on the island. As mentioned elsewhere, there is no surface connection between this pond and the ocean. This particular pond was about 4½ miles N.N.E. of Arthurs Town and roughly about one-fourth mile wide and one and one-half miles long. High land was found on all sides but the north where there was a mangrove swamp about one-half mile long between this pond and another one. It possessed a tide of about two feet and had a definite saltwater fauna. It is very deep, how deep we cannot say as we possessed no means of getting out to make soundings. The natives are extraordinarily afraid of the place and will hardly venture even within the limits of the mangrove fringe which skirts the entire margin of the pond. It unquestionably possesses subterranean connections with the ocean as the mangrove area on the north was only covered with a few inches of water during the full high-tide.

Temporary shallow ponds (freshwater). East of Arthurs Town, about one-half mile from the sea, there was a low, somewhat slightly rolling area that extended for one-half mile in an easterly direction and better than two miles in a general north and south direction. Within this area there was a vast number of small ponds, individual ponds seldom exceeding 200 feet in diameter. These small shallow freshwater ponds were separated by rounded ridges of limestone with patches of thin soil cover. Palmetto, cocoplums and sedges made up much of the vegetation growing on the thin soil of this area. Most of these ponds are dry during the late fall and winter but well filled during the rainy period of the year. We collected a few freshwater mollusks in these ponds that were not obtained elsewhere.

Permanent deep ponds (fresh-water). Two very deep ponds were found east of Orange Creek, the first about one-half mile and the second about one and one-half miles. These were called "fountains" locally and were said to contain water always. The most important element in these two places was the presence of fresh-water fish which occurred in considerable numbers. A few of the temporary ponds in this vicinity also possessed fresh-water fish, but apparently these were derived from the "fountains" during the high water stage. Both of these "fountains" occurred in the area of temporary ponds mentioned above.

A recent publication by Pease, Creaser and Hall (1936) describes in detail the geological formation and the fauna of the cenotes of Yucatan. It would seem, to judge by the description of the above authors, that the two "fountains" that we encountered on Cat Island were small cenotes quite similar to those occurring in Yucatan. The one nearest to Orange Creek had a high undercut west wall fifteen to twenty feet high. The approach to the water had to be made in its eastern side which was quite steep but not at all precipitous. The second "fountain," or cenote, was filled nearly to the brim with clear and rather cold water. The bottom could not be seen.

The temporary ponds that we encountered were similar to the "aguadas" mentioned in the above report (p. 12). They were, however, much shallower. Hall quotes Cole as suggesting that the "aguadas" are partially filled in cenotes and advances his own theory that certain of them "represent a persistence of sea bottom depressions that were never caverns or wells." Of the two theories, the latter certainly is more plausible for the ponds that we encountered, inasmuch as their bottoms under a few inches of mud were composed of solid rock and not the débris from erosion of their margins as was suggested by Cole.

On somewhat higher ground we found several small, dry "sinks," eight to fifteen feet deep and about the same in diameter. Rich soil occurred at the bottoms and were generally used by the natives to grow bananas. The differences between these sinks and the cenotes is really a matter of degree, the latter being smaller and drained. We were told of much larger sinks than those that we had seen, and it is quite possible that the two are geologically the same thing.

Land habitats. With the exception of *Cerion*, *Hemitrochus* and *Plagioptycha*, the few species of land mollusks found on Cat Island are mainly cryptic. During rains they move about a little, but generally they remain under stones or débris.

Inner coastal strip. The western fringe of this island is quite irregular ecologically, but in the main, is composed of low lying "diente de perro" and short sandy beaches. Below Bennetts Harbour the land rises somewhat to form bluffs several feet high. We have not seen this section but it is probably like the north central inner coastal area of Eleuthera where there are bluffs 20 to 60 feet high, undercut at the water line. Behind this coast the land for a few hundred feet to one to two miles is slightly elevated, rolling and in places possesses the brackish swamps and fresh-water pond areas described elsewhere. Sandy-loam areas are not abundant but where they occur they are intensively cultivated.

Ridge area. The central part of the island is composed of irregular rocky ridges covered generally with a low scrub forest. Several patches are burned and farmed. This is the richest in mollusks and the rarer forms such as *Urocoptis, Microceramus, Helicina,* the Pupillidae, etc., are met with in greater abundance than elsewhere. Loose rocks abound and ample cover is provided for the secretive forms. *Cerion* is absent as well as *Polygyra.*

Outer coastal ridge. This is a sandy-loam or "white land" area which runs along the eastern coast behind the beach proper. It is generally cleared and farmed. Uncultivated areas possess thickets of scrubgrowth, grass and spider lilies. *Cepolis* and *Cerion* usually occur here in the greatest profusion. The *eximium* group of races is absent entirely, only the larger forms, *russelli, felis* and *huntingtoni* are to be met with. West of this ridge is usually low lying with many brackish ponds and swamps. *C. eximium* is, however, found in this area.

Marine habitats. Marine conditions in the Bahamas are more or less uniform throughout the entire archipelago, particularly on the islands that form the easterly margin of the Great Bahama Bank, Eleuthera, Cat and Long Islands.

The outer, or northeasterly, sides of these islands consist of long and short stretches of beaches interrupted by rocky headlands and bluffs. Exposed as they are to the easterly trades, there is very little protection afforded and the fauna is limited not only in species but in numbers of individuals. This coast is nearly devoid of bays, inlets or places where protection can be had from the full force of storms. When such exists, there is usually an abundance of marine life.[1]

The southwest coasts are far more irregular in outline, with numerous bays, harbors and "creeks" and, of course protected as they are from the tradewinds, are much richer in marine forms. This is also the "bank" side of the islands and the sea is comparatively shallow for a considerable distance offshore.

Due to the lack of suitable habitats particularly in the form of mud flats minute species are comparatively rare. Mud with a high content of organic matter is exceedingly scarce and exists only as small patches at the heads of the "creeks" which usually support areas of mangrove. Even here the conditions have become altered as these areas are generally brackish and consequently exclude forms peculiar to a purely marine existence. The western side of Andros Island is known

[1] Savannah Sound on the northeast side of Eleuthera is a narrow strait some 6 miles long and about ¼ of a mile wide. Ample protection is to be found and conditions are ideal for marine forms. A more detailed account of this area has appeared elsewhere (Clench and McLean, 1937, p. 33).

as "The Mud." This area is composed of a calcareous mud derived from the western shore of this island and, according to Miner and Dahlgren ([in] R. M. Field, 1931, pp. 769–774) was found to be exceedingly poor in marine life. This is probably due to both the chemical and physical nature of this material, that is, the lack of suitable organic detritus upon which many of the small mollusks feed (the above authors report that "vegetable debris was sometimes locally abundant") and also because of the turbidity of the water which occurs after storms or even during moderate winds which cause sufficient wave action to stir up the bottom.

There are no surface streams of fresh water on Cat Island or, for that matter, anywhere in the Bahamas[1] as the drainage is all subterranean, and as a consequence there is little or no opportunity for land sediment to reach the sea in any appreciable quantity. What little does reach the sea, is generally carried away by the shore currents, the only exception being, as mentioned above, at the heads of certain creeks.

In general, the littoral marine mollusks of the Bahamas are similar to those of the Greater Antilles. Far more collecting is necessary before any accurate comparative studies can be made, but the differences found between the Bahamas and the islands immediately south will probably not be very great. The difficulty is in a proper understanding of what constitutes the limiting factor in the non-occurrence or lack of abundance of certain species in the islands, species which occur both in Florida and in the West Indies under conditions more or less approximating those of the Bahamas. Mechanics of distribution are certainly not enough to explain the presence or absence of a species in this region, particularly when comparisons are made with adjacent and similar territory. This is true when a species is known to occur both in the Bahamas and elsewhere, but only known from a single or few specimens in the former territory and found abundantly in other portions of its range.

The student of geographical distribution is faced with gaps in the record of marine forms that are not due altogether to the unexplored portions of a species range. Factors in the ecology of a species must be discovered before any clear picture of its distributional pattern can be had.

Anomalies in the distribution of many Bahama species seem to be far more erratic than elsewhere, as for example species occurring on the

[1] Fresh Creek on Andros is not a true creek, but a tidal channel that is fresh or only slightly brackish at its source.

west coast of Florida. Species found along this latter area are surprisingly uniform in their distribution between Cedar Keys on the north and Pavillion Key on the south, a distance of some 275 miles. Many species, of course, are not found extending throughout this range, but within their range limits they occur more or less regularly under similar circumstances. On the other hand, all sorts of discrepancies are to be noted in the distribution of many Bahama species. The beaches at Arthurs Town possessed a remarkably different assemblage of lamellibranchs from the beaches in and about Governor's Harbour, Eleuthera. Both places are on the "inside" coasts of the islands and both have somewhat similar offshore physical conditions. Certain of the common species are, of course, found nearly everywhere but many others show surprising gaps between localities. The problem does not appear to be an easy one.

Geological notes

For general remarks on the geology of the Bahamas, reference should be made to Schuchert (1935, pp. 528–540).

Cat Island is distinctly hilly, a character held in common with other islands along the outer and eastern edge of the Great Bahama Bank. These hills are lithified sand dunes with portions of the outer ridge still composed of unconsolidated sand and light sandy loam which is known locally as the "white land." Similar but smaller areas of "white land" are found as well on the leeward sides of these islands.

Soil cover on the northern end of Cat Island is exceedingly light and in areas other than the "white land"is reduced mainly to the solution holes and depressions among the rocks.

Caves are to be found on most of the larger islands though they are not particularly numerous and nowhere are they extensive. Bat guano, which is found in many of these caves, has been and still is used for fertilizer, more extensively now than in former times as the tomato industry has received a considerable impetus during the past few years. There is no question but that much valuable cave data has been lost from all of these islands, due to their exploitation for guano, as the little investigation so far attempted in these caves has shown a comparatively high index of finds, mainly in the form of skeletal remains of small mammals, birds and even the bones of the extinct Lucayan Indians.

We saw no evidence in the form of elevated strand lines on the northern part of Cat Island. We did, however, find portions and whole

shells of *Strombus gigas* that were embedded in the coastal rock 6 to 10 feet above the present sea level on the south side of Little San Salvador. At several places along this coast there exists a terrace some 10 feet high with a vertical cliff rising as high as 20 feet behind it. Many places at the base of the cliff were undercut and probably this represents an old strand line. (The truncated dune mentioned elsewhere, p. 504, occurred along this part of the coast.) During April, 1936, Mr. J. C. Greenway and I noted a small but similar "undercut" on Mores Island on the Little Bahama Bank. We estimated this undercut at the base of a rocky hill (now inland about 250 feet) to be about 15 feet above the present sea level. In addition, we noted a remarkable feature on Grand Bahama Island. We had the advantage of seeing this entire island with a seaplane several times from the air. Other than a narrow fringe of low scrub growth of deciduous trees and bushes along the south side, the area of the island above sea level supports a stand of Bahama pine. This pine appears to be entirely limited to the rocky land where there is but very little soil. At many places we saw narrow, grassy swales cutting through the island from north to south and these appeared from the air to represent old "creek" beds that existed during a time of higher oceanic level and are now completely filled in. From a ground study, these old creeks would be unsuspected though they are definitely outlined from the air. Hawksbill Creek is now the only one of these former tidal creeks that has remained open. This creek flows alternately with the tide owing to a differential in tide level on the two opposite sides of the island. At the eastern extremity of Grand Bahama there is a series of long and comparatively narrow, low, rocky islands with narrow, shallow straits between them. These islands also support a stand of the Bahama pine. A change of as much as 15 feet in the present sea level would probably produce a similar condition as that noted above on Grand Bahama proper. However, it is quite probable that these small islands existed at the same time when Grand Bahama was cut by several creeks and have remained open owing to a difference in the speed of tidal flow. The eustatic change was probably slow enough for these straits to cut down their beds as the oceanic water was lowered. It is to be borne in mind that north of Grand Bahama the banks are margined only by the open sea while on the eastern end tidal drainage is blocked by both Little and Great Abaco and, as a consequence, the set of the current both on the ebb and flow of the tide is much stronger around this eastern end of Grand Bahama.

I have not seen Andros Island, but judging entirely by its known

low elevation, it is possible that the present channels which now divide this island, may have had their origin at the time of higher oceanic level and have since been able to maintain their courses by cutting down their beds. This same condition may have developed the present series of Exuma Islands and the long string of islands extending northwest of Great Abaco. These may represent the fragments of once larger islands and they are only the remains of former dunes that were subsequently cut through at their low points during this higher oceanic level (c.f. Daly, 1934, pp. 157–164, for evidences of a 5–6 meter change of sea level). This same process may also have produced the Berry and Ragged Island groups, both of which margin the banks.

Field (1931, p. 780) reports, on the work of Dixon, several strand lines at various elevations, all under 8 feet, along the western edge of Andros, the Berry Islands and the Bimini Islands, and upon this evidence, concludes that there has existed a "slight but distinct warping." Similar elevated strand lines that we have seen on the easterly islands are higher and may represent a eustatic change of ocean level rather than any vertical elevation of Little San Salvador or Mores Island.

Evidence of a one time lower sea level exists at Arthurs Town in the form of the remnants of a lithified dune that still margins the coast. It remains today as a series of miniature headlands, islets, or submerged rocks. A small section of this ridge formed a cove at the south end of the town. Elsewhere in the Bahamas there are the remains of dunes that have been similarly cut away by action of the sea, notably at West End, Grand Bahama Island and along the North coast of Little Abaco. At this latter locality, a series of rocks occurred a few hundred feet off Foxtown, which were undoubtedly the remains of a former ridge, as they were in a line paralleling the coast. Many of these rocks were reduced to only a few feet across and were mushroom in shape owing to the present undercut. Their tops were flat and appeared to be approximately eight feet high.

The speed at which this coastal limestone may form is indicated by the presence of extraneous objects, such as a piece of iron chain, parts of bottles and a small, 5–6 pound boulder of igneous rock, all of which we found imbedded in the limestone at Arthurs Town. These objects we had to cut out with cold chisels. We were informed by the natives that many boulders such as the one we found embedded, were common years ago on Cat Island but have long since been removed for building purposes. Their origin, of course, dates from the heyday of agriculture,

probably during the development of the pineapple industry when these boulders came as ballast in boats from the United States.

This would then indicate that certain of this limestone is very recent and has become consolidated in the space of a very few years. Small changes in the configuration of the coast line, brought about by shifting sand bars or storms, have now exposed this newly formed rock to erosion and the included objects are brought to light.

Systematic Account

Prior to our visit to Cat Island, there had been but few land shells collected. The records listed below are the results of only casual collecting by people limited in their time on the island.

During the winter of 1865–1866, Dr. Henry Bryant stopped for a short time at The Bight, Cat Island, while on his way to Great Inagua Island. A few species of shells were collected, one of which, *Helix salvatoris*, was described by Pfeiffer in 1867. The Cerions collected were identified as other species, now known to be limited to other islands. Confusion regarding the locality of *C. cumingiana* Pfr. lead Bland and others to consider the material of Bryant as this species. Later Pilsbry restricted this species to Cuba, and described the Cat Island form as *C. eximium fraternum*.

Later, Dr. J. J. Brown collected, probably in this same area on Cat Island, and published a short paper in the Conchologists' Exchange, 1886, **1**, pp. 12–13, on the material collected. Pilsbry described *Helix troscheli brownii* on specimens collected by Brown.

A few published records and some museum specimens possess localities as "San Salvador," a name employed as an alternate for Cat Island. This has lead to some confusion, as Watling Island in the Bahamas is also known as San Salvador. Cat Island is not to be confused with Cat Cay in the Berry Islands (north of Andros) and Cat Cay in the Bimini group.

Species in the following list, marked with an asterisk (*) are considered elsewhere in this report, the remaining species are misnamed or wrongly assigned to Cat Island. All geographic records without authorities were collected by the present expedition.

**Hemitrochus troscheli brownii* Pilsbry.

**Cerion eximium* Maynard.

**Cerion felis* Pilsbry and Vanatta.

**Cerion fordii* Pilsbry and Vanatta.

**Cerion fraternum* Pilsbry.

Cerion marmoratum (Pfeiffer) reported by Pilsbry and Vanatta (1896, Proc. Acad. Nat. Sci. Phila. p. 326) from Cat Island. This species is now known to occur only on Fortune Island in the Crooked Island group.

Cerion martensi (Weinland) reported by J. J. Brown (1886, Conch. Exchange **1**, p. 13) from Cat Island. It is known to occur only on Crooked Island in the Crooked Island group.

Cerion mumium (Bruguiere) reported by J. J. Brown (*ibid.* p. 13). It occurs only on the North Coast of Cuba between Matanzas and Havana.

**Cerion platei* Clench.

**Physa acuta* Dall (= *P. cubensis* Pfr., q. v.)

**Plagioptycha duclosiana salvatoris* Pfeiffer.

Original citations are given for all of the species in this report, additional citations are those in which references were made to Cat Island. The localities at which we collected or from which we received material are indicated on the two maps.

Land and freshwater mollusks

HELICINIDAE

Alcadia (Alcadia) fallax A. Wagner

Alcadia fallax Wagner 1907, Conchy.-Cab. **1**, pt. 18, sec. 2, p. 56, pl. 8, fig. 13–15 (New Providence, Bahamas); Clench 1937, Proc. New England Zoöl. Club **16**, p. 73.

A local and rare species, known only from the type locality and from the few localities listed below for Cat Island.

Records. Arthurs Town; ½ mi. N. E. of Orange Creek; Blue Hole Hill; Port Howe.

Helicina convexa rawsoni Pfeiffer

Helicina rawsoni Pfr. 1867, Malak. Blätt. **14**, p. 165 (Inagua Id., Bahamas); Clench 1937, Proc. New England Zoöl. Club **16**, p. 75.

This form appears to be only a subspecies of *H. convexa* Pfr. of Bermuda. The differences are slight but quite constant. The parietal callous is more granulose in the Bahama form and the lip is somewhat consistently thicker. However, other than these two characters, the two forms are very similar.

Records. Between Orange Creek and Port Royal.

POMATIASIDAE

Opisthosiphon bahamense ('Shuttleworth' Pfeiffer)

Ctenopoma bahamense 'Shutt.' Pfr. 1865, Mono. Pneumonopomorum Viven. **3** p. 115 (New Providence, Bahamas).

Opisthosiphon maynardi Vanatta 1920, Proc. Acad. Nat. Sci. Phila. **72**, p. 204, pl. 6, fig. 9–11, 13 (Nassau, New Providence).

This species was never described by Shuttleworth but was only named by him from material contained in the Cuming collection which had been received through Bland, possibly from W. Cooper or T. Smitten.

It appears to be well distributed throughout a large portion of the Bahamas, and it may occur in considerable abundance at a favorable station. Specimens are to be seen moving about a little after rains, but it is generally to be found under loose stones and rocks.

This species over its entire range in the Bahamas is somewhat variable, the variation not appearing to be particularly geographic. In a very large series from most of the islands, the same variations keep appearing. It would seem as though certain slightly different characters are segregated in small areas, even on the same island. Specimens from the island of New Providence are more consistently darker in coloration than specimens from most other islands, and examples from Long Island have the axial, blade-like ridges slightly wavy, but there are specimens from many other localities that approximate these characters. The sculptural pattern, however, shows the least amount of variation.

Records. Arthurs Town; ½ and 1½ mi. N. E. of Arthurs Town; Orange Creek; Blue Hole Hill.

Opisthosiphon bahamense insulae-felis new subspecies

Plate 2, fig. 1 and 7

Description. Similar in general characters to the typical form, differing quite noticeably in the sculpture. *O. bahamense* Pfr. possesses fine, blade-like ridges, numbering about 8–10 to the mm. This new subspecies has fewer, much stronger and higher ridges, numbering 3–4 to the mm. In addition, each ridge has a single bead or boss at the suture; in the typical form two and sometimes three ridges are generally fused. This is the character that produces the crenulated suture. Under a 14 power lens, a few, microscopic axial threads are just visible between the ridges.

Length 12.5; width 5.7; aperture 3 x 2.8 mm. (holotype).

Holotype. Mus. Comp. Zoöl. no. 107905, Port Howe, southern end of Cat Island, Bahama Islands. E. Williams collector, July, 1936. Paratypes from the same locality. All specimens dead when collected.

Remarks. O. bahamense barbouri Cl. from Watling Island is more or less intermediate in the character of its sculpture between this new subspecies and the typical form, but it differs in many other respects, particularly in the rounded and thickened lip, its smaller size and almost closed umbilicus. From *O. androsense* Pils. it differs in being larger and having only a trace of the spiral threads or cords.

Chondropoma canescens (Pfeiffer)

Plate 2, fig. 5

Cyclostoma canescens Pfr. 1851, Proc. Zoöl. Soc. London p. 245 (Locality not given).

A species widely distributed in the Bahamas and eastern Cuba, though not particularly abundant at any one place in the former area.

In habit, it appears to be quite solitary, preferring areas of scrub growth and loose surface stones. This species, similar to other closely related forms, is semi-arboreal, though active only during wet weather. It will ascend trees for a short distance and upon the weather drying, secrete a short mucous thread from which it suspends itself. Any slight disturbance, even a light breeze, will rupture this thread and the snail drops to the ground, remaining dormant until the next period of wet weather activates it again.

A comparison has been made between a large series of specimens from several localities in both the Bahamas and eastern Cuba. No differences could be detected to separate these forms, even subspecifically.

Records. Arthurs Town; 1 mi. S. E.; 3 mi. N. W.; and 4 mi. E. of Arthurs Town; Orange Creek; ½ mi. and 2½ mi. N. E. of Orange Creek; Winding Bay; Bain Town; 3 mi. N. W. of Port Howe.

ELLOBIIDAE

Melampus coffeus (Linne)

Bulla coffea Linne 1758, Sys. Nat. ed. 10, p. 729.

An abundant species in the mangrove swamps throughout the West Indies.

Records. Arthurs Town; Orange Creek; Russell Creek.

Melampus coffeus flavus (Gmelin)

? *Voluta flava* Gmelin 1792, Syst. Nat. p. 3436.
Melampus flavus, Binney 1863, Boston Journ. Nat. Hist. **7**, p. 166, fig. p. 167.

It is exceedingly difficult to separate these forms. It is quite possible that *flavus* is only an ecological variety of the more abundant *coffeus*.

Records. Arthurs Town; North East Point, 4 mi. E. of Arthurs Town.

PHYSIDAE

Physa cubensis Pfeiffer

Physa cubensis Pfr. 1839, Archiv. für Naturgeschichte **1**, p. 354 (Cuba); Clench 1936, Mem. Soc. Cubana Hist. Nat. **10**, p. 339, pl. 25, fig. 2.
Physa acuta Drap., Dall 1905, Smithsonian Misc. Colln. **47**, pt. 4, no. 1566, p. 448 (Mangrove Cay, Andros and Watling Island); 1905, The Bahama Islands. The Geographical Soc. Baltimore, p. 41 (Arthurs Town, Cat Island).

In a former paper (Clench, 1936, p. 339) I placed *P. acuta* Dall in the synonymy of *P. cubensis*, as there appears to be no difference at all between specimens from the Bahamas and those from other portions of the West Indies. It certainly is not the common European *P. acuta* Drap.

We found the species fairly abundant in the freshwater ponds east of Arthurs Town. Its present distribution in the Bahamas would indicate that it will possibly occur wherever there is any fresh water.

Records. Arthurs Town (Dall); ½ mi. E. of Arthurs Town; ½ mi. N. E. of Orange Creek.

PLANORBIDAE

So far as known, all of the large species but one of the Planorbidae are absent from the Bahamas. Dall records *P. redfieldi* C. B. Ad. from Andros Island, but this appears to be the only record. The specific identity of this record, however, is questionable.

The following forms were all obtained in the small ponds behind Arthurs Town and Orange Creek. Their occurrence in certain small dried up ponds (on Cat Island and Grand Bahama Island) would indicate either the comparative ease in transport between such places or else their ability to withstand fairly long periods of desiccation, a condition which may be passed over during adult life buried in the dried pond soil or in the egg stage in the debris of the pond bottoms.

Drepanotrema cimex (Moricand)

Planorbis cimex Moric. 1839, Mem. Soc. Phys. Geneve **8**, p. 143, pl. 3, fig. 8–9 (Bahia, Brazil).

Records. Arthurs Town; ½ mi. due E. of Arthurs Town; ½ mi. N. E. of Orange Creek.

Drepanotrema lucidum (Pfeiffer)

Planorbis lucidus Pfr. 1839, Arch. f. Naturg. **5**, pt. 1, p. 354 (Cuba).

Records. Arthurs Town; ½ mi. due E. of Arthurs Town; ½ mi. N. E. of Orange Creek.

Planorbula albicans (Pfeiffer)

Planorbis albicans Pfr. 1839, Archiv. f. Naturg. **5**, pt 1, p. 354 (Cuba).

Records. Arthurs Town; ½ mi. due E. of Arthurs Town; ½ mi. N. E. of Orange Creek.

Tropicorbis havanensis (Pfeiffer)

Planorbis havanensis Pfr. 1839, Archiv. f. Naturg. **5**, pt. 1, p. 354 (Cuba).

Records. Orange Creek; ½ mi. N. E. of Orange Creek.

VAGINULIDAE

Vaginula schivelyae bahamensis (Dall)

Veronicella schivelyae bahamensis Dall 1905, Smithsonian Misc. Collections **47**, pt. 4, p. 446, pl. 49, fig. 1 (Nassau and Little Abaco).

Very abundant in and around Arthurs Town and elsewhere on northern Cat Island. They are to be found under stones and trash during the day but appear exposed crawling at night or during rainy periods. Certain of the older natives told us that this species (referred to as "land curb")[1] was originally unknown on the island but it made its appearance when the Australian Pine was introduced. This, of course, may not be true, but it is also possible that commerce was responsible for its introduction. Our specimens agree with Dall's diagnosis, but it is still uncertain whether this subspecies may not be

[1] All chitons are referred to in the Bahamas as "sea curb" or just "curb" which is possibly a corruption of the word "curve." When chitons are removed from the rocks they coil like certain land isopods or "pill bugs." The Vaginulidae do this to a more limited extent, and this habit may have given rise to the use of this word.

identical with other West Indian forms. The entire family is in need of a careful revision.

Records. Arthurs Town.

SUCCINEIDAE

Succinea barbadensis Guilding

Succinea barbadensis Guilding 1828, Zoölogical Journal **3**, p. 532 (Barbados).

Rare, though fairly well distributed in northern Cat Island. Specimens were found mainly at the grass roots and around the base of stones.

Records. Arthurs Town; ½ mi. due E. of Arthurs Town; ½ mi. N. E. of Orange Creek; Blue Hole Hill.

PUPILLIDAE

Gastrocopta pellucida (Pfeiffer)

Pupa pellucida Pfr., 1841, Symbolae ad Hist. Hel. **1**, p. 46.

Found rather abundantly under stones and in soil pockets.

Records. Arthurs Town; ½ mi. N. E. of Arthurs Town; Blue Hole Hill; Little San Salvador and Goat Island, 1 mi. N. E. of Little San Salvador.

Pupoides modicus (Gould)

Pupa modica Gould 1848, Proc. Boston Soc. Nat. Hist. **3**, p. 40 (Florida).

Generally distributed on northern Cat Island but not so numerous as *Gastrocopta*.

Records. Arthurs Town; ½ mi. E. of Arthurs Town; Blue Hole Hill.

SUBULINIDAE

Subulina octona (Bruguiere)

Bulimus octonus Brug. 1792, Encycl. Meth. **1**, p. 325. (Gaudeloupe and Santo Domingo).

Records. Arthurs Town; ½ mi. due E. of Arthurs Town.

Opeas gracile (Hutton)

Bulimus gracilis Hutton 1834, Jour. Asiatic Soc. Bengal **3**, p. 93 (Mirzapur, Ceylon).

Records. Arthurs Town; 1½ mi. N. E. of Arthurs Town; Orange Creek.

Both *O. gracile* and *S. octona* are widely distributed in the Bahamas though not particularly abundant other than in a few localities. They prefer damp situations under stones, boards or palm fronds and appear to be more common in regions of human occupation.

OLEACINIDAE

Oleacinia (Laevoleacina) solidula (Pfeiffer)

Polyphemus solidula Pfeiffer 1840, Wiegm. Arch. **1**, p. 252 (near Matanzas, Cuba).

This species appears to be generally distributed throughout the Bahama Archipelago. It is rather secretive in habit, remaining for the most part under stones and debris, moving freely only during wet weather. It was not found abundant at any station.

In addition to its distribution in the Bahamas, it also occurs in Cuba and the Isle of Pines. Though it varies slightly in shape, the variation does not appear to be geographic, specimens from any one locality usually exhibit the variation range found in specimens from many different localities.

Records. Arthurs Town; ½ mi. due E. of Arthurs Town; Ridge 1½ mi. N. E. of Arthurs Town; ½ mi. N. E. of Orange Creek; Blue Hole Hill.

Pichardiella bahamensis (Bartsch)

Varicella gracillima bahamensis Bartsch 1913, Proc. United States Nat. Mus. **46**, p. 109, pl. 3, fig. 13 (Mangrove Cay, Andros Id., Bahamas).

Exceedingly rare and limited in distribution.

Record. Arthurs Town.

POLYGYRIDAE

Polygyra plana (Dunker)

Helix plana Dunker 1843, Abbildungen Neuer Conchylien, Cassel, **1**, p. 51, Helix, pl. 3, fig. 11 (? West Indies).

Polygyra plana bahamensis Vanatta 1919, Nautilus **33**, p. 72 (Current Settlement, Eleuthera, Bahamas).

(For a complete list of references and synonyms of the species, see Vanatta, E. G., 1910, Proc. Acad. Nat. Sci. Phila. **62**, p. 664.)

I am unable to separate *P. plana bahamensis* Vanatta from the typical form, originally described from Bermuda (see Vanatta, above). Several topotypes of Vanatta's variety (part of the same series collected by C. J. Maynard in 1897) were examined and the differences stated by Vanatta were not at all consistent. Several specimens were cut back without finding the parietal lamina mentioned for the Bahama form. There is no question but that it probably exists in certain specimens, but in the present case appears to be rare. It would seem to be a physiological character, a predisposition of certain specimens to produce the parietal tooth during its early development, which under normal conditions, is not developed until the animal has reached its growth morphologically. In this way, a low ridge or lamina, is produced along the parietal wall as the shell grows forwards. In most specimens this does not occur until the shell is fully grown, and results only in a rather large parietal tooth. It also appears in some specimens as a discontinuous lamina, appearing for a portion of a whorl only. This same condition exists in certain of the southern Florida Polygyras, a few specimens from the same locality possessing this lamina and not found at all in others.

Ecologically, this species prefers damp situations, usually under palm fronds, palm logs and stones. We did not find it at all on the high and dry portions of the ridges behind Arthurs Town. Certain equivalent species in Florida are found climbing grass and other low herbage, even in the salt marsh area. We found it very abundant at a few stations.

Records. Arthurs Town; ½ and 1½ mi. N. E. of Arthurs Town; ½ mi. N. E. of Orange Creek.

SAGDIDAE

Hojeda inaguensis (Weinland)

Helix inaguensis Weinl. 1880, Jahr. Deut. Malak. Gesel. **7**, p. 369, pl. 12, fig. 22 (Little Inagua).

Rare and limited to the ridges.

Records. Blue Hole Hill, 2 mi. N. N. E. of Orange Creek.

Lacteoluna selenina (Gould)

Helix selenina Gould 1848, Proc. Boston Soc. Nat. Hist. **3**, p. 38 (Georgia and Florida).

Well distributed in northern Cat Island but rare at any one place.

This species prefers the underside of stones. Live specimens possess a very coarse and ragged periostracum which is quickly lost when the mollusk dies.

Records. Arthurs Town; ½ mi. E. of Arthurs Town; Blue Hole Hill; Port Howe.

CERIONIDAE

Cerion, the only recent genus in this family, is probably one of the most remarkable ecologically among the land pulmonate gastropods of the West Indies. Other than in the Bahamas and Curacao, it is to be found only in the immediate vicinity of the sea. This ecological condition is not to be confused with the habit of most genera in the family Ellobiidae which are to be found in a salt or a brackish swamp area. *Cerion* are not found in a "salt marsh" or "mangrove" association or with any type of swamp or normally wet situation, but are found on dry soil or rocky land above and beyond the high watermark. In wooded areas they are semi-arboreal, climbing the trees, sometimes to a considerable height, but usually within fifteen feet of the ground. Elsewhere they will be found on bushes, cacti, grass and stones, and even under stones if plant cover is at all scarce. In Cuba, *Cerion* is usually found from the upper limit of the shore to about 500 feet inland, seldom more. In the Bahamas, they may be found a few miles inland, which is probably due to the greater distance that the salt spray can be carried in these generally and comparatively flat islands or to the presence of inland brackish water areas. We are unable to say just what the limiting factor is, i.e. the existence of salt in the form of dried spray, or lichens upon which they feed which may be peculiar to the same region. It would appear to be the former, to judge entirely by the fact that they will feed on other substances such as wafer fish food and even paper, if sufficient moisture is present to keep them active.

According to Dall (1905, p. 30) the genus *Cerion* dates from the Oligocene and at that time definitely occupied a group of islets which now form a part of the north central portion of Florida. The genus probably occurred at this time in Cuba and perhaps elsewhere in the Greater Antillean region, though as yet no fossil species have been found earlier than the Pleistocene in this area as far as I can determine.

The extraordinary complexity of this genus is due apparently to two very important factors, the relative instability of most of its characters and that of a colonial habit. These factors can be enlarged upon as follows:

Variability. All of the general characters in *Cerion* are subject to considerable variation, that is, the presence or absence of color, being ribbed or smooth, having an open or closed umbilical area, having a great difference in size and having the lip built forwards, thickened or back folded. To these characters there can be added the variation in the position, length and size of the apertural teeth, the presence or absence of minute sculpture and the variation in shape. With such a large number of variable characters the differentiation possible is almost endless.

Colonial habit. The most important factor, however, appears to us to be the colonial habit, a condition that is exceedingly rare in mollusks. This is not to be confused with colonies of any one species of mollusks that are limited by the nature of their environment to occupy any particular area. Cerion will group themselves into large or small colonies within an ecological territory which is much larger than the area that the colony will occupy. Upon field evidence these colonies will migrate from one part of an area to another. Migration may be exceedingly slow, a matter of years to cover a distance of a mile. This migration habit associated with their definite colonial existence has probably been responsible for the very great complexity of the genus. Individuals in a single colony resemble one another more closely *in the mass* than they do individuals of another colony. Certain individuals of any one colony in a species may approximate or exactly duplicate individuals of another colony. Even distinct colonies may be very close in their mass characteristics, though exact colonial duplication is practically unknown. This factor then may prove to be the underlying cause for the remarkable and extraordinary variation, as the colonial habit produces periods of isolation during which certain of the characters become fused through the unit population, the migrating tendency eventually brings about a union of two or more colonies with a consequent mixing of the colonial characters, the result usually being an astounding number of individual variants. Mechanical mixing by means of hurricanes is exceedingly difficult to prove, but the potential factor in the habitat situations occupied by these mollusks is certainly present for such a mode of dispersal. They cling to dead palm fronds, bark and other vegetation subject to mechanical transport and in certain cases are held temporarily captive in the pinnate leaflets of the coconut and palmetto fronds. In such a manner they could be readily transported by the caprice of any hurricane to a new situation. A striking relationship, which is possibly of this type, is that between *Cerion huntingtoni* (new) of Cat Island and *C. fairchildi*

Cl. of Conception Island. The two species are very close to some common ancestral stock not far removed in the past. The depths of the ocean between Cat Island and Conception are great (741 fathoms) and it doesn't seem possible that such a relationship would date from the time that these islands were connected, if such a connection ever did exist. Conception Island lies about 25 miles S. E. of Columbus Point, the nearest part of Cat Island, and the type locality for *C. huntingtoni*. Mechanical distribution either one way or the other does not seem impossible between these two islands.

As reiterated elsewhere, hurricanes have probably played an important part in the present distribution of the Bahama mollusks and perhaps other faunistic elements on these islands. As the Bahama Cerions generally are arboreal (limited, however, to the lower parts of trees and bushes) aerial distribution at such a time is not only possible but highly probable.

The distribution of *Cerion* within limited areas is not necessarily continuous. Perhaps one of the most important facts to be borne in mind is the strong colonial segregation exhibited by the many species. Just what limits the area of each colony is not always clear. Many times physical barriers are evident and the margins of each colony are delimited by salt pans, bare rock, marsh land, or lack of suitable plant life. On the other hand, colonies are to be met that are limited in area with no definable barriers to restrict their distribution beyond the known boundaries of such a colony. Such colonies may be new and are now slowly enlarging their present boundaries. It is quite possible, of course, that other barrier factors not apparent may be present. In regard to this last statement, many times during field work, mainly in Cuba, dead shells of a particular species will be encountered in considerable numbers in a region with no living examples of the species available. A few hundred feet to several kilometers away the same species may be found living in countless numbers. This is particularly true for species that exhibit a definite colonial organization. More evenly distributed species show a distributional pattern that coincides with a particular type of habitat or else limited by some physical barrier. Their individual migrations are not directional as a colonial unit, but they tend to dispose themselves more or less evenly throughout a given type of ecological territory.

It now appears among the Cerionidae that the greater the isolation, the greater the uniformity among the individuals of a colony. Both *C. utowana* and *C. greenwayi*, the first from East Plana Cay, the second from Atwoods Cay, exhibit a remarkable degree of uniformity

among all the individuals obtained from these two well isolated islands. The same is true of *C. fairchildi* from Conception Island. On the other hand, species occurring on the larger islands where many colonies of several species or races occur, tend to be extraordinarily variable. Here, a mixture of colonies is possible by both migration and mechanical distribution which results in a fusion of all the individual characters possessed by the colonies that are mixed.

Section Strophiops[1]

Cerion felis Pilsbry & Vanatta

Plate 1, fig. 1–4

Cerion (*Maynardia*) *felis* P. & V. 1895, Proc. Acad. Nat. Sci. Phila. p. 206 (Cat Island).

Cerion felis P. & V. 1896, Proc. Acad. Nat. Sci. Phila. p. 322, pl. 11, fig. 29; H. A. Pilsbry 1902, Man. of Conch. (2) **14**, p. 221, pl. 44, fig. 72–73.

This species was described from a single specimen with the locality only as Cat Island, originally received from T. Bland. Williams collected a very large series of this species from near Turtle Cove, 4 mi. N. N. E. of The Bight, Cat Island. It is a species of the exposed eastern side of the island.

Many specimens exhibit considerable irregularity in the production of the whorls, these being offset either above or below a normal whorl. In a few specimens the upper three or four whorls are tipped over at a slight angle as though the early whorls had been broken from the rest and then cemented together again, the repairing being poorly executed.

A few additional measurements are given to supplement that of the holotype (A.N.S.P.).

Length	Width	Whorls	
28.	11.5 mm.	10.5	Holotype (A.N.S.P.)
30.8	11.	11.	Topotype
30.7	11.2	10.	"
30.9	12.6	10.5	"
28.5	12.5	10.	"
32.5	12.3	11.	"

Several specimens from this place agree with the holotype in size, shape and in the number of whorls so that Turtle Cove can be considered the type locality.

[1] All Cerions from Cat Island are members of this section.

Cerion huntingtoni, new species

Plate 3, fig. 1–3

Description. Shell subcylindrical, stout, solid, with the umbilical rimation closed or only minutely open. External color a chalk-white with the interior of the aperture a pale, creamy brown. Whorls 9½ to 10½, last three, somewhat flattened, remaining earlier whorls sharply tapering to an obtuse summit. Spire somewhat short, conic, and slightly convex, produced at an angle of 83° (holotype).[1] Aperture subovate to nearly circular. Parietal tooth strongly developed, centrally located and about three times as long as high. Columellar lamella much smaller but carried back for a full whorl. Lip expanded, flattened and generally recurved. Parietal lip well thickened, usually enough to connect the insertion points of the palatal lip. Suture well defined, sharply though not deeply indented. Sculpture generally of strong and widely spaced ribs, variable in number (18–23) and occasionally nearly obsolete. Nuclear whorls (1½) smooth. Basal ridge inconspicuous, the ribs continuing into the umbilical rimation.

Length	*Width*	*Aperture*	
30.5	13.5	8.5 x 6.7 mm.	Holotype
25.5	13.2	7.5 x 6.5	Smallest
31.3	13.	8. x 6.5	Largest
28.8	13.6	8.2 x 6.6	Average of 10 specimens

Holotype. Mus. Comp. Zoöl. no. 106956, Columbus Point, S. E. tip of Cat Island, Bahamas, E. Williams collector, July, 1935. Paratypes (2000±) from the same locality.

Remarks. This species is materially different from all others encountered on this island and the only species of the *regina* group known to occur on Cat Island. In relationship, it appears to be closely related to *C. fairchildi* Clench from Conception Island which is located about 25 miles S. E. of Columbus Point. It differs from that species in being a little smaller, more coarsely ribbed, has a less produced spire and a very much darker coloration within the aperture. A single colony only of this species was collected.

Cerion glans (Kuster)

Pupa glans Kuster 1844, Conchy.-Cab. **1**, pt. 15, p. 74, pl. 11, fig. 1–2 (Locality unknown) [Nassau, New Providence, Pilsbry 1902, p. 260].

All of the localities from which specimens of this widely distributed Bahama Cerion were obtained are located near the central portion of

[1] A series of 10 specimens, however, gave a variation of this angle from 73° to 85°.

Cat Island. They occurred usually on the outer coastal strip. The specimens collected are a little more mottled than typical *glans* of New Providence, the remaining characters are similar.

Records. Bachalar; Knowles; 1 mi. E. of Hollywood; 3 mi. E. of Smith Town; Old Bight; Turtle Cove Settlement.

Cerion (strophiops) liliorum, new species

Plate 2, fig. 2–4

Description. Shell cylindrical, solid, ribbed, tapering and rimately perforated. Color white to dull grayish brown. On colored shells the ribs are generally white. Interior of aperture a pale brownish cream. Whorls 10½ to 11, the first full whorl smooth and opaque white, the remaining whorls strongly ribbed. Generally the first 6 whorls form a fairly acute cone to the spire, the remaining later whorls more or less parallel sided. Spire produced at an angle of 78°. Aperture subcircular. Parietal tooth centered, fairly high but not long. Columellar tooth situated low, not very high but carried backwards for a full whorl giving a twisted appearance to the columella within. Lip full and beveled, built slightly forwards and forming a parietal ridge. Sculpture of somewhat coarse and numerous, slightly irregular ribs with about 23–26 on the body whorl.

Length	*Width*	*Aperture*	
32.0	14.0	8.1 x 6.8 mm.	Holotype
31.2	13.3	7.5 x 6.0	Paratype
30.9	14.0	7.8 x 6.2	"
30.7	14.2	8.0 x 5.8	"
32.3	13.3	8.0 x 6.1	"
28.3	13.1	7.5 x 5.5	"
29.2	12.1	7.2 x 6.5	"
28.5	13.5	7.5 x 6.0	"
28.0	13.1	7.8 x 5.5	"
25.6	12.5	6.8 x 5.5	"

Holotype. Mus. Comp. Zoöl. no. 116086, Next Point, (east coast) 1½ miles E. N. E. of Governors Harbour, Eleuthera Island, Bahama Islands. W. J. Clench collector, May, 1936.

Remarks. Specimens of this species were first collected on Little San Salvador Island in 1935, but they were rare and only a limited series was obtained. For this reason, Eleuthera Island is taken as the type locality for the species inasmuch as a very extensive series is at hand for study. These were collected at several localities in 1936, all

along the outer or eastern shore of Eleuthera, all places within a few miles of Governors Harbour.

This species is a member of the *Cerion glans* group as outlined by Pilsbry (1902, p. 249). From typical *glans* it differs in being somewhat larger, proportionately heavier and possesses a well formed perietal ridge. From *C. glans coryi* Mayn. it differs in being much lighter in color, larger and heavier. The umbilical rimation in *liliorum* is longer and generally with a very small perforation. Both possess the strong parietal ridge.

We found specimens most abundant on the wild spider lilies along the exposed eastern shore of Eleuthera. On Little San Salvador they occurred on a small patch of these lilies on the north side of this small island. It did not occur on Cat Island.

Cerion (strophiops) russelli, new species

Plate 1, fig. 5–8

Description. Shell cylindrical, rather elongated, strong but not solid, coarsely ribbed and usually minutely perforated. Color dull greyish brown, rarely mottled. Whorls 10 to 11, first 1½ smooth, remainder ribbed, fine and numerous at first, then becoming coarse and heavy and rather widely spaced on the later whrols. Spire acute, the cone of about 7 whorls, remaining whorls more or less parallel sided. Cone of spire forming an angle of 74° (holotype). Aperture subovate. Parietal tooth short and not very high. Columellar tooth small and follows within for about one whorl. Lip reflected, rather flat, rarely thickened or back folded. Parietal ridge well developed. Suture well defined and slightly indented. Umbilical perforation small and usually present. No pronounced basal ridge. Sculpture of numerous and strong ribs, with widely spaced intervals variable but usually 1½ to 2 mm. apart, and numbering 18 to 20 on the body whorl. A few specimens possessed fine spiral incised lines.

Length	*Width*	*Aperture*	
32.8	13.5	8.2 x 7 mm.	Holotype
32.7	13.5	8.3 x 6	Paratype
31.5	13.7	9. x 6.8	"
32.	13.2	8. x 6.5	"
32.4	13.8	8.5 x 7.	"
31.	13.7	8.5 x 7.5	"
30.	13.3	8. x 6.	"
27.7	12.5	7.2 x 5.5	"
27.3	13.6	8. x 7.	"
26.6	14.	7. x 6.5	"

Holotype. Mus. Comp. Zoöl. no. 107534, near Turtle Cove, 4 mi. N.N.E. of The Bight, Central Cat Island, Bahama Islands. E. Williams collector, July, 1935.

Remarks. This species appears to be an aberrant form in the *glans* group though it is somewhat intermediate between this group and that of *Cerion felis* P. & V. There appears to be no question but that certain specimens are hybrids between this form and *felis*. Colonies of both were found in the same general area, on the windward side of the island.

From *C. glans, C. russelli* differs by being very much larger, proportionately thinner and in having a flatter, non back folded lip. Only a single colony of this form was obtained on Cat Island and its specific relationships are not clear.

Cerion fordii Pils. & Van.

Cerion fordii Pils. & Van. 1897, Proc. Acad. Nat. Sci. Phila. p. 365, text fig. 1–2 (Bahamas).

Cerion fordii submarmoratum Pils. & Van. 1897, Proc. Acad. Nat. Sci. Phila. p. 365, text fig. 3–4 (Bahamas).

The exact locality of this species is still unknown. It appears to be close to *C. eximium* and in all probability occurs on Cat Island, possibly in the southern portion of the island. The variety *submarmoratum* does not seem to us to constitute a valid form, it differs but slightly from *fordii* P. & V. but not nearly as much as certain colonial elements in *eximium*. Plate (1907, p. 608) referred specimens that he had collected on Cat Island to this species, but they proved upon later examination to be a new form. This was described as *platei* (q.v.).

Cerion platei Clench

Cerion (*Strophiops*) *platei* Clench 1933, Proc. New England Zoölogical Club **13,** p. 90, pl. 1, fig. 7–8 (Bight Road, Cat Island, Bahamas).

This species appears to be limited to the lower and east coastal region of the island. It seems to be fairly close in its relationships to *eximium* Mayn. differing particularly in the remarkable development in the collared or back-folded lip.

Records. Old Bight; Middle Bight; Devil Point (L. Plate, as *C. fordii*).

Cerion eximium (Maynard)

Plate 3, fig. 4–8

Strophia eximea Maynard 1894, Contributions to Science **2,** p. 177, fig. 59a–b, 61a–c (Cat Island).

Cerion eximium, Pilsbry 1902, Man. of Conch. (2), **14**, p. 265, pl. 38, fig. 76–78; Pilsbry 1896, Proc. Acad. Nat. Sci. Phila. p. 326; Dall, W. H., 1905, [in] The Bahama Islands, Geographical Society of Baltimore, p. 41; Maynard, C. J. 1920, Records of Walks and Talks with Nature, appendix, **10**, p. 126, pl. 10, fig. 1–2.

Maynard (1894, p. 179) received his specimens of *C. eximium* from a Mr. Curtiss of Nassau who in turn had received them from a native of Cat Island. Specimens of the type series are identical to those of Arthurs Town and probably originally came from there. This place can be considered the type locality.

This is by far the most abundant species of *Cerion* found on northern Cat Island. It existed in many diverse types of habitats, though it was absent from the higher ridges. It did not occupy the extreme outer or eastern coastal strip but did occur a short distance behind. As far as we are able to ascertain, all members of this group in the Bahamas, such as *eximium* (Cat, Long and Eleuthera Islands); *agrestinum* (New Providence), *bendalli* (Gt. Abaco), etc. do not frequent the exposed outer sides of these islands, though rarely they may exist a short distance behind the sandy ridge or rocks along the shore. The extreme outer area usually possesses an entirely different assemblage of Cerions if any members of the genus are present at all.

Cerion eximium is a polymorphic species, occurring as smooth, costate, mottled or white. Extreme forms exist as smooth-white; smooth-mottled; costate-white and costate-mottled. These four types possess all of the possible intergradations.

About half of the colonies of this species were found to consist of very similar specimens, the remainder showed a little to a great deal of variation. Generally, the isolated colonies, protected by minor barriers exhibited the greatest uniformity both as to the morphological structure of the shell and the degree and type of coloration.

The distribution of smooth, mixed and costate colonies, however, was not irregular. The few smooth colonies were all found on the lee coast near the sea; the costate forms along the lee coast and again behind the outer rampart along the windward coast. The mixed colonies occurred both on the lee and windward coast and at several places in the interior. We have seen no specimens of *eximium*, even near the outer or windward coast, at any place other than northern Cat Island. Also, in an extensive series of *eximium* from Eleuthera and Long Island, no colonies exhibited the wide range of colonial variation nor the strongly costate forms exhibited by the series from northern Cat Island. Our only explanation is that the ecology of the region may

be a factor in some way responsible for the development of these strongly costate examples. There are many other species of *Cerion*, perfectly smooth, that live along the exposed coasts of these islands, and elsewhere, such as in Cuba, so that it is evident that ecology alone is not a controlling factor, though it may be a force of some extent with certain species. It is of value to note that *C. johnsoni* and *scalarinum* Pfr. (Cuba), *felis* (Cat Island) and *steavensoni* (Long Island) all live close to salt water along the exposed sides of these islands and they are the most costate and rough species known.

The following localities are those from which we obtained the several colonies of *C. eximium* on northern Cat Island. They are grouped according to their structure of being smooth, costate or occurring together in a colony of both smooth and costate individuals.

Smooth

Wilson Bay; Bennetts Harbour; The Lot; Rock Cay, Bennetts Harbour.

Costate

Anguilla; 3 mi. S. of North East Point; Coarsand; Dumfries; Zion Hill; False Creek; Smoky Point; south side of Smoky Point Lake; between Orange Creek and Port Royal; Wilson Bay.

Smooth and Costate Forms

Barrataria; Winding Bay; Fountain Hill; Bat Hole; Grape Point; Zingo Hill; Laurimore; Orange Creek; North End Point; Mt. Pleasant; Arthurs Town; North East Point; near Rock Point, Bennetts Harbour; Stormy Battle.

Cerion eximium fraternum Pilsbry

Cerion eximium fraternum Pilsbry 1902, Man. of Conch. (2), **14**, p. 265, pl. 38, fig. 79–80 (San Salvador, ex. Bland); Dall, W. H., 1905, [in] The Bahama Islands, The Geographic Soc. Baltimore, p. 41.

This is a diminutive race of *Cerion eximium* and apparently quite rare. We did not find it on northern Cat Island, though it occurred sparingly on Little San Salvador. A few specimens found at this latter locality are hybrids, between *fraternum* and *liliorum*.

The exact type locality is unknown but as Bland had received other species of Cat Island material from near the center of the island, it is quite probable that his *fraternum* material came from the same area.

The type lot described by Pilsbry was in the Swift collection, originally supplied by T. Bland. The original collector was H. Bryant, who had collected at The Bight, San Salvador during a trip to Gt. Inagua in 1866.

UROCOPTIDAE

Members of this family occurring in the Bahamas are all more or less cryptic in habit, seeking protection under stones or in the plant debris of the solution holes, usually on the tops of the weathered limestone blocks. All of the species are found most abundantly in the rocky areas upon the higher portions of the islands. Most species in this family, particularly in Cuba, are to be found in exposed situations, though a limited number of forms occupy the same ecological station.

Urocoptis bahamensis providentia Pilsbry

Urocoptis bahamensis providentia Pils. 1903, Man. of Conch. (2) **15**, p. 280, pl. 65, fig. 21–22 (Nassau, New Providence).

This is a rather widely distributed species in the Bahamas, occurring on the Abaco Islands on the Little Bahama Bank and most of the large islands of the Great Bahama Bank. So far, only Mariguana possesses this species among the isolated islands of the southeast.

It seems questionable whether this form should be separated subspecifically from *Urocoptis bahamensis* Pfr. The typical species is only slightly smaller, other characters are identical. Pfeiffer described his specimens of the typical species from Nassau, receiving them originally from Poey and it is possible that they came from a locality that has subsequently been destroyed as no others quite as small have been collected since on New Providence.

Records. Near Arthurs Town; 1½ mi. N. E. of Arthurs Town; Blue Hole Hill.

Microceramus providentia Pilsbry

Microceramus gossei providentia Pils. 1904, Man. of Conch. (2) **16**, p. 161, pl. 26, fig. 16 (Nassau, New Providence).

Widely distributed on the northern Bahamas, usually more abundant than *Urocoptis*. It is found in the same habitat.

Records. Arthurs Town; ½ mi. and 1½ mi. N. E. of Arthurs Town; Blue Hole Hill.

Microceramus russelli Clench

Microceramus russelli Clench 1937, Proc. New England Zoöl. Club **16**, p. 63, pl. 3, fig. 4–5 (Blue Hole Hill, 2 mi. N. E. of Orange Creek, Cat Island).

A much rarer form than the last and known only to occur on Cat, Long and Mariguana Islands.

Records. Arthurs Town; Blue Hole Hill.

CEPOLIDAE

Hemitrochus varians (Menke)

Helix varians Menke 1829, Conch.-Samml. Malsburg, p. 5.
Helix (*Hemitrochus*) *varians*, Pilsbry 1889, Man. Conch. (2) **5**, p. 24, pl. 13, fig. 59–63.

This is the most abundant, and widely distributed, land mollusk on Cat Island. It is to be found nearly everywhere above high water line from the low coastal areas to the tops of the central ridges of the island. It is usually rare in the thick vegetation, preferring somewhat open exposed areas. It lives on bushes and small scrub growth, showing a decided preference for the spider lilies that are found along the sandy ridge on the outer northeast side of the island.

Band coloration in this species is exceedingly complicated in addition to a complex ground color plan. No studies as yet have been made to see if certain color groups have any geographical significance on the islands. It would also appear that in certain localities this species will hybridize with *H. troscheli brownii* Pils., the only other *Hemitrochus* on Cat Island. Elsewhere on the island these two forms apparently intermingle without crossing.

H. varians is not a true colonial land mollusk. Its abundance in any one place is apparently due to conditions best adapted for the species. Its absence from suitable areas is generally due to recent fires, as the dead and charred "bones" are in evidence nearly everywhere in such stations.

Records. The following are only a few of the many places at which the species was obtained. Stations are included that were made by the "Utowana" on the 1934 trip as well as those made by M. Williams and others. This species, curiously enough, was not heretofore recorded for Cat Island.

Hawksnest Point (Barbour & Greenway); Baintown, 3 mi. N. W. of Port Howe; Columbus Point; Turtle Cove, 4 mi. N. N. E. of The

Bight (all southern and central Cat Island); Arthurs Town; Orange Creek; Rock Cay; Bennetts Harbour; North End Point (all northern Cat Island). Little San Salvador.

Hemitrochus troscheli brownii Pilsbry

Helix (*Hemitrochus*) *troscheli brownii* Pilsbry 1889, Man. of Conch. (2) **5**, p. 29, pl. 31, fig. 27. (Cat Island, Bahamas).

So far as known, this subspecies of *troscheli* is confined to Cat Island. Pilsbry (loc. cit.) has emphasized its carinated condition though this, as well as other characters, varies considerably and many specimens would certainly fit the characters of *H. troscheli* proper.

It is not as common as *H. varians*, neither in distribution nor the abundance of individuals at any one station.

Records. Cat Island (J. J. Brown), [These were probably collected near The Bight in the central part of the island.] Anguilla Flat, 2 mi. N. E. of Arthurs Town; Bat Hole and White Pond, about 2½ mi. N. E. of Orange Creek; Bain Town, 3 mi. N. W. of Port Howe, southern Cat Island.

Plagioptycha duclosiana salvatoris (Pfeiffer)

Helix salvatoris Pfeiffer 1867, Malak. Blätt. **14**, p. 127 (Bight of San Salvador, Bahamas).

Helix (*Plagioptycha*) *duclosiana salvatoris*, Pilsbry 1889, Man. of Conch. (2), **5**, p. 19, pl. 11, fig. 13–15.

Widely distributed on Cat Island. It seldom appears in any great numbers, but during dry weather several specimens will collect at one point, such as under a piece of loose bark or under the leaves of vines that cling to the tree trunks. Under more unfavorable conditions a few specimens will be found secreted under loose stones. This appears to be a very good subspecies, differing quite constantly from the typical form by its lengthened apertural tooth which, in addition, is situated nearer to the lower margin of the lip. There is, however, some variation.

Records. Bight of San Salvador (Pfeiffer); Cat Island (Dall), a few records only are given as it was collected at nearly all stations visited. Arthurs Town; Smoky Point Lake, 4 mi. E. of Arthurs Town; Grape Point, 5½ mi. N. of Arthurs Town; North End Point, 5 mi. N. W. of Arthurs Town; Roker Settlement, 9 mi. S. E. of Arthurs Town.

SPHAERIIDAE

Byssanodonta bahamensis, new species

Plate 2, fig 6

Description. Shell small, inequilateral, transversely-oblong, moderately compressed. Beaks prominent but not particularly full. Anterior end short and rounded, posterior end much broader, rounded but terminating above at a rather straight hinge line. Color a dull brownish yellow, mottled with black over the disk. Sculpture of very fine concentric ridges. Rest stages indicated by a sharply raised ridge.

Length	*Height*	*Width*	
5.7	4.6	3. mm.	Holotype
6.5	5.2	3.2	Paratype

Holotype. Mus. Comp. Zoöl. no. 107726, ½ mi. due east of Arthurs Town, Cat Island, Bahama Islands. Clench, Russell, Huntington collectors, July, 1935. Paratypes from the above locality and from ½ mi. N. E. of Orange Creek.

Remarks. This is the first recorded species in the family Sphaeriidae from the Bahamas. It is closely allied to *B. cubensis* (Prime), but differs in several rather consistent minor characters. The present new form is more compressed with the beaks less full and the anterior area shorter. The sculpture of *B. bahamensis* is coarser, but this character may possibly vary with habitat conditions.

The specimens were all dead when found, mixed with the damp earth of partly dried up "aguadas" in the swamp land back of Arthurs Town and again at Orange Creek. It was not at all abundant at the localities collected. Mr. Greenway and I collected it at West End, Grand Bahama Island in April, 1936.

Relationships of the Cat Island Mollusks

Thirty-eight species and subspecies are listed above for this island.[1] Additions, of course, are to be expected when the lower part of the island is more fully explored, but the number added, however, will probably not be great. Certain of these, such as *Truncatella, Pedipes* and other Ellobiids which we did not find, are generally distributed throughout the West Indies and will add nothing to the immediate problem of origin.

Of the 38 forms, 17 occur elsewhere in the Bahamas (4 of these also extend their range to the Bermudas, Florida and Cuba) and 13 others

[1] *Cerion liliorum*, the thirty-ninth, is not known from Cat Island but is limited to Little San Salvador and Eleuthera.

are of general distribution in the West Indies and beyond. The remaining 8 species and subspecies are endemic and are closely allied to forms existing elsewhere in the Bahamas, all but 2 are *Cerion*.

Eliminating the species that are widely distributed in the Bahamas and the West Indies proper, there are but 11 that are endemic or of limited distribution outside of Cat Island. Of the non-endemic species, *Alcadia fallax* occurs elsewhere only on the island of New Providence, *Microceramus russelli* on Long and Mariguana islands and *Byssanodonta bahamensis* on the island of Grand Bahama.

The relationship of the endemic forms to others are as follows: *Cerion felis* to *C. stevensoni* of Long Island; *C. huntingtoni* to *C. fairchildi* of Conception Island; *C. russelli* to the *glans* group of Cerions of wide distribution in the Bahamas; *C. fordii, C. platei* and *C. eximium fraternum* to members of the *martensi* group also of wide distribution in the islands. The two remaining endemics, *Hemitrochus troscheli brownii* and *Opisthosiphon bahamense insulae-felis,* are subspecies of wide ranging Bahaman forms.

It is to be seen from the above that the diverse origin of the molluskan fauna of this single island parallels the condition that exists for the Bahamas as an island group. Any previous land connection with the Great Bahama Bank would necessarily have been by way of Eleuthera, over what is now the submerged ridge that joins these two islands. Yet it is surprising that the restricted and really critical species should only occur on distant islands and not on Eleuthera. The same is equally true for the relationships of certain of the endemic forms.

I would infer from this evidence that at least a portion of the mollusk fauna is fortuitous, and that the mechanical agencies responsible for the original Bahaman fauna have also aided in populating Cat Island.

Echinoderms

Determined by H. L. Clark

ASTEROIDEA

**Luidia alternata* Say[1]
Oreaster reticulatus (L.)
Linckia guildingii Gray
Echinaster sentus (Say)

[1] Species marked with an asterisk are recorded from the Bahamas for the first time. All are from Arthurs Town.

OPHIUROIDEA

Ophiothrix oerstedii Ltk.
Ophionereis reticulata (Say)
Ophiocoma echinata (Lam.)
Ophiocoma pumila Ltk.
Ophiocoma riisei Ltk.
Ophioderma appressum (Say)
Ophioderma brevicaudum Ltk.

ECHINOIDEA

Tripneustes esculentus (Leske)
Echinometra lucunter (L.)
**Echinometra viridis* A. Ag.
Clypeaster rosaceus (L.)
Mellita sexiesperforata (Leske)
**Echinoneus cyclostomus* Leske
Brissus brissus (Leske)

HOLOTHURIOIDEA

Thyone surinamensis Semper
Holothuria floridana Pourtales
Holothuria impatiens (Forskål)

List of Cat Island Reptiles and Amphibians
Determinations by T. Barbour and B. Shreve[1]

Epicrates striatus strigilatus (Cope)
Tropidophis pardalis barbouri Bailey
(Utowana Exp., 1931–1932)
Alsophis vudii vudii Cope
Sphaerodactylus decoratus Garman
Sphaerodactylus notatus Baird
Anolis distichus Cope
Anolis ordinatus Cope (Utowana Exp., 1934)
also Little San Salvador and Goat Cay
near northern Cat Island
Anolis smaragdinus Barbour and Shreve

[1] All of the listed species were collected by the 1935 expedition, with records of earlier collectors added.

Leiocephalus carinatus virescens Stejneger, also Goat Cay, northern Cat Island

Ameiva thoracica Cope (Utowana Exp., 1934), also Little San Salvador, northern Cat Island

Pseudemys felis Barbour (W. G. Albury and C. S. Dolley)

Hyla septentrionalis Boulenger (Utowana Exp., 1931–1932)

Eleutherodactylus ricordii (Duméril and Bibron)

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